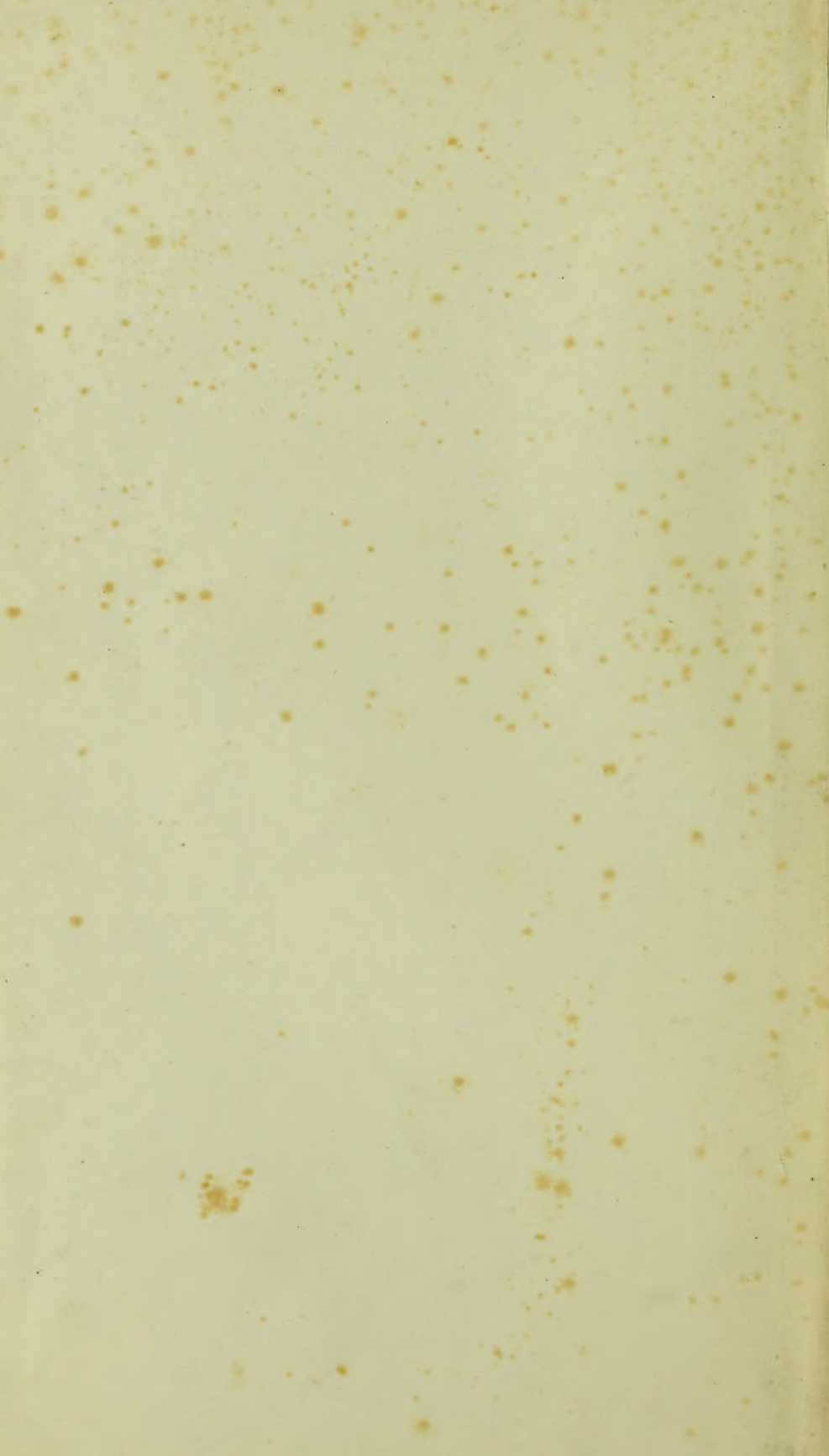





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A
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VOL. III.

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A SYSTEM
OF
SURGERY

THEORETICAL AND PRACTICAL

IN TREATISES BY VARIOUS AUTHORS

EDITED BY

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AND OF THE URINARY ORGANS; VENEREAL DISEASES; OF THE FEMALE
AND MALE SEXUAL ORGANS; OF THE THYROID GLAND; ANÆSTHETICS;
MINOR SURGERY; PLASTIC SURGERY; AMPUTATION; EXCISION;
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Edited by T. HOLMES, Esq.

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By J. HUTCHINSON, ESQ.

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By the late HOLMES COOTE, ESQ.

Edited by J. W. HAWARD, ESQ.

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By J. LISTER, ESQ., F.R.S.

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Edited by R. LYELL,

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By R. LYELL,

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By T. HOLMES, Esq.

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SURGICAL DISEASES OF CHILDHOOD.

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INCLUDING

CONGENITAL DISLOCATION AND INTRA-UTERINE FRACTURE,

By B. BRODHURST, Esq.

Orthopædic Surgeon to St. George's Hospital;

AND

RICKETS.

By A. SHAW, Esq.

Consulting Surgeon to the Middlesex Hospital.

Edited by Dr. W. J. LITTLE,

Formerly Physician to the Orthopædic Hospital.

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¹ These sections are by B. Brodhurst, Esq.

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By W. J. LITTLE,

Formerly Physician to the Orthopædic Hospital.

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By G. HARLEY, M.D., F.R.S.

Physician to University College Hospital.

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ON PARASITES, AND THE DISEASES WHICH THEY PRODUCE.

By G. BUSK, Esq., F.R.S.

Late Surgeon to the Dreadnought Hospital Ship.

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By G. BUSK, Esq., F.R.S.

Late Surgeon to the Dreadnought Hospital Ship.

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By T. HOLMES, Esq.

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Assistant Surgeon to University College Hospital.

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THE THIRD VOLUME.

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DISEASES OF THE ABSORBENT SYSTEM.¹

THE vessels and the glands of the Absorbent System are closely associated in their diseases, and cannot be conveniently or advantageously studied apart from one

Errata.

VOL. III.

Page xiv. Table of Contents, No. IV., *for* laparotome *read* laparotomy.

" 56, line 8, *for* diseases *read* divisions.

" 120, *transfer* Lane's case, No. 4, Section I. *a.* (where the artery tied was the left carotid), *to* Section II. *a.*; and Knowles's case, No. 4, Section II. *b.* (where it was the right carotid), *to* Section I. *a.*

" 121, line 4 from bottom, *for* 1859 *read* 1839.

" 133, " 13, *for* external *read* extensor.

" 135, " 5, " are " as.

" 181, " 1, " about " absent.

" 244, " 20 from bottom, *for* or *read* on.

" 318, " 48, *for* (figs. VIII. and IX.) *read* (figs. IX. and X.).

" 319, " 15, *transfer* above mentioned *to after* experience, line 14.

" 328, " 14 from bottom, *for* pressure *read* prepuce.

" 372, " 26, *for* primary *read* suppurating.

" " 32, " elevation " ulceration.

" 535, " 15 from bottom, *for* deisases *read* diseases.

" 548, " 1, *for* that *read* than.

" 675, " 13 from bottom, *for* ovis *read* oris.

" 693, last line, *for* and excisions *read* excision of cicatricial bands, and replacement by transplantation.

" 720, line 15, *for* fixed *read* flexed.

" 781, note ³, " removed by Sir B. Brodie *read* operated on by another surgeon against Sir B. Brodie's advice.

London a case which closely resembled those related by Dr. Carter, except that the urine was not chylous. The right lower extremity of a boy began to enlarge at two and a half years of age, and when he was seven, the whole limb was thickened, the penis and scrotum swollen with distended lymphatics, and chylous fluid escaped from minute vesicles and openings at the frænum and on the scrotum, as well as on the lower extremity itself. On a particular examination it appeared that the limb was not merely infiltrated with chyle, but was also overgrown, the bones and muscles participating no less than the skin and cellular

¹ In this, as in the other essays by deceased authors which I have revised, I have put Mr. Moore's statements into the third person, and have distinguished those for which I am myself responsible by the use of the first person.—[T. H.]

² Hewson, Sydenham Society's edition, by Gulliver, p. 198.

³ *Medical Essays*, Edinburgh, vol. v. art. 27. Several more cases of real or supposed injury to the thoracic duct or large lymphatic trunks at the root of the neck are collected by Dr. Busey in the article on 'Injuries and Diseases of the Absorbent System' in the American reprint of the second edition of this work. Dr. Busey concludes that, if from lesion of the thoracic duct the entrance of chyle into the venous blood be entirely prevented, life cannot be long sustained, and that any very copious loss of chyle will seriously endanger life; and this is very probable. Pressure on the thoracic duct and obstruction to the flow of chyle has long been recognised as one of the causes of emaciation in aneurisms of the abdomen and thorax.

⁴ *Medico-Chirurgical Transactions*, vol. xlv. p. 189.



DISEASES OF THE ABSORBENT SYSTEM.¹

THE vessels and the glands of the Absorbent System are closely associated in their diseases, and cannot be conveniently or advantageously studied apart from one another. In the following essay, therefore, a separate notice of either part of the system will be taken only when some special facts of pathology or of treatment render it necessary.

Wounds of lymphatics.—Although some of these vessels cannot fail to be injured in every considerable wound, they are rarely noticed. A little lymph doubtless issues from them, but it is mixed with the more copious and more important outflow of blood, or with the subsequent oozing of interstitial fluids from the divided tissues. The wounded lymphatic tubes may be sealed by the common coagulum of blood; it is probable, however, that the lymph also by its own consolidation contributes to this effect.

In some few instances, as in those mentioned by Hewson² and by Monro,³ wounded lymphatic vessels have furnished a copious discharge of clear coagulable fluid, such as is seen in lymphatic fistula; but the symptom is usually one of little surgical importance.

Lymphatic fistula and œdema.—Lymphatic fistula is usually a complication of congenital hypertrophy, or of hypertrophy from elephantiasis of the lower limb, scrotum, or vulva.

Dr. H. Vandyke Carter, of the Bombay Medical College, met with three cases in which he had reason to think that chyle escaped by leakage or rupture from lacteal absorbent vessels. Alternately with this cutaneous leakage of chyle, a similar fluid passed in the urine, and Dr. Carter concluded that the disease known as 'chylous urine' is not a functional error of the renal or digestive organs, but an accidental admixture of chyle with urine by the rupture of a lacteal vessel, concurring with a breach of the mucous surface in some part of the urinary tract. The patients were Hindoos, in whom great but varying swelling took place in the scrotum and groin. In one of the cases a fluid resembling chyle sometimes issued, and after food copiously, from a spontaneously formed and very minute opening in the skin of the thigh.⁴ In March 1869, Dr. Day communicated to the Clinical Society of London a case which closely resembled those related by Dr. Carter, except that the urine was not chylous. The right lower extremity of a boy began to enlarge at two and a half years of age, and when he was seven, the whole limb was thickened, the penis and scrotum swollen with distended lymphatics, and chylous fluid escaped from minute vesicles and openings at the frœnum and on the scrotum, as well as on the lower extremity itself. On a particular examination it appeared that the limb was not merely infiltrated with chyle, but was also overgrown, the bones and muscles participating no less than the skin and cellular

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³ *Medical Essays*, Edinburgh, vol. v. art. 27. Several more cases of real or supposed injury to the thoracic duct or large lymphatic trunks at the root of the neck are collected by Dr. Busey in the article on 'Injuries and Diseases of the Absorbent System' in the American reprint of the second edition of this work. Dr. Busey concludes that, if from lesion of the thoracic duct the entrance of chyle into the venous blood be entirely prevented, life cannot be long sustained, and that any very copious loss of chyle will seriously endanger life; and this is very probable. Pressure on the thoracic duct and obstruction to the flow of chyle has long been recognised as one of the causes of emaciation in aneurisms of the abdomen and thorax.

⁴ *Medico-Chirurgical Transactions*, vol. xlv. p. 189.

tissue in the overgrowth. The reporting committee expressed an opinion that this hypertrophy of the limb was intimately connected with the distended state of the lymphatics, and they referred to four other cases in which lymphorrhagia with dilated lymphatics was associated with hypertrophy of the affected part, as well as to researches of Virchow upon hypertrophy of the tongue, which show that in that disease the muscular overgrowth is also of lymphatic origin. The boy died at the age of sixteen with very obscure symptoms. The post-mortem examination threw no light on the causes of death, nor on the nature of the disease.¹

An obstructed condition of lymphatic vessels has been proved to lead to a 'solid œdema' of the cellular tissue, a hypertrophied or 'elephantine' condition of the integument, and in some cases a great increase in the muscular structure of the part, such as existed in Dr. Day's case above quoted; though in that case no enlargement or obstruction was found in the larger lymph-channels. These cases of lymphatic œdema have been described by Mr. J. Hutchinson and by the late Mr. Messenger Bradley,² and I have had occasion to see several of them, but have not had any opportunity for post-mortem examination. The symptoms have much resembled those above detailed in Dr. Day's case, though without the lengthening of the limb, which was so remarkable in that patient. Attacks of a sort of erysipelas or erythema are common in these cases, and appear to favour the increase of the hypertrophy, and the patients often suffer from frequent accessions of low fever; which, in a woman under my care who had considerable lymphatic œdema of the vulva, groin, and thigh, seemed to be connected with menstruation. The real pathology of these cases is still obscure. Allowing that some have been proved to depend on obstruction in the thoracic duct or larger lymphatics, many cases have been examined in which nothing of the sort was found, and the enlarged varicose condition of the smaller absorbent vessels, though it may account for the hypertrophy and the lymphatic fistula, leaves the constitutional condition still unexplained. Beyond careful bandaging, absorbent and astringent applications to the hypertrophied skin, and attention to the general health, I know nothing that can be usefully done. One of the forms of elephantiasis is of this nature, and the reader is referred to the essay on DISEASES OF THE SKIN for further information on this subject.

Inflammation of lymphatics—Adenitis, Angielerucitis.—In most instances of inflammation in the absorbent system, the vessels and the glands are both involved; the glands are rarely, the lymphatic vessels almost never, attacked alone. Many cases of inflammation of glands (*adenitis*) are regarded as spontaneous, or as the result of the direct influence of cold, until a careful inquiry shows them to be dependent on a prior irritation of the afferent lymphatic vessels (*angielerucitis*). It is by no means unlikely, therefore, that some inflammations, which are now considered to be instances of primary adenitis, may yet be found to be secondary to some hitherto undiscovered primary cause of the same kind.

Inflammation of the lymphatics occurs in many parts of the body. Traces of it are sometimes discovered in the interior of the trunk, after death, by the various changes it has produced; by serum or pus; by thickening, opacity, or accumulated concretions in or about the lymphatic vessels. But it is hardly ever actually seen except in connection with the skin or an ulcerated surface.

The disease, as it thus comes under the observation of surgeons, is usually an acute inflammation, originating in some previously irritated or inflamed tissue, extending in long narrow lines in the course of the absorbent vessels, and involving the nearest gland. It is often attended with heat and a transient redness of the adjoining skin, with considerable pain, and with rather severe symptomatic fever; and it may issue in an effusion of serum and lymph, in suppuration, and in blood-poisoning.

Most inflammations of the absorbents start from an open wound. Such a wound may be in almost any condition, and of any form. It may be punctured, cut, torn, blistered, torpid, healing, scabbed. The mere state of the wound does not determine

¹ *Clin. Soc. Trans.* vols. ii. p. 104; xi. p. 214.

² See the chapter on 'Lymphatic Œdema,' in Bradley on *Injuries and Diseases of the Lymphatic System*.

the occurrence of the inflammation. It may, indeed, manifest itself after the absorption of a poison without a wound, as when red lines cover the penis from recently contracted gonorrhœa; even breathing the exhalations of corrupting animal matter may occasion it, although the wound from which the angeioleucitis afterwards spreads be at the time sedulously covered; but there is in most cases ample evidence of direct infection of the wound. The morbid matter may be some local inflammatory product, as when the inflammation follows the prolonged friction of excoriated skin, or the confinement of the secretions of a sore by a hard scab. More commonly, however, some irritating or poisonous material is known to have been applied to the wound from without; or some gaseous poison, though not known, may be the real, as it is sometimes the ascertained, cause of the inflammation. Dr. Greenhow describes inflammation of the absorbents of the arm as succeeding a diphtheritic exudation beneath a vesicle of the hand.¹ He has seen the same occurrence in the neck, connected with diphtheria of the throat, and fatal. Mr. Moore saw once a very rapid case of secondary cancer (referred to on p. 10), in which the first infection of the glands was accompanied and indicated by acute inflammation of the lymphatics with redness of the skin.

The course of the inflammation is commonly pointed out by a linear redness of the skin, which is often many times broader than the vessel beneath. The lines follow the direction of the absorbents, not of the veins; and in the arm they may cease at the wrist, or the elbow, or at any intermediate part at which the inflamed lymphatic vessels end in a gland, or lose relation with the skin; but they never pass the armpit. The tenderness along such inflamed tracks is excessive, and it commonly extends to the next absorbent gland, whether the redness reach so far or not. The rapidity with which such lines are sometimes formed is remarkable, and is only equalled by the instantaneous ophthalmia which occurs when a foreign body enters the eye.

Mr. Hunter saw a case, in which the skin being pricked by a needle which had never been used before or touched any infectious or irritating substance, occasioned the lymphatics of the arm to inflame, and show themselves in the form of red lines, running towards the axilla: in consequence of this, some one of the glands there also inflamed and swelled, the patient had rigors and sickness, and all this in the space of a few minutes.¹

Such extreme rapidity in the development of inflammation is unquestionably rare, although Cruikshank states that he has seen other similar cases in the instance of the absorbents. The red lines, indeed, are not invariably formed; and this may be readily understood, if they be regarded as occurring only when the inflammation is widely spread, and therefore rather intense.

The inflammatory action, as indicated chiefly by these red lines, sometimes extends slowly, and as it were continuously, by the tissue of the lymphatic vessels; far more commonly it attacks them simultaneously in nearly their entire length, and appears to be consequent on their becoming filled with fluid of an irritating quality. That the latter is the mode of origin is further likely from the fact, that the disease travels only upward from the wound to the next gland, and not in the opposite direction. It will extend, for instance, from a wound on a knuckle to the axilla, but not along the finger; from the heel to the ham, but not to the foot. There are some apparent exceptions to this rule, but they are probably to be explained by the continued absorption of noxious matter at the wound, and its accumulation below some point of obstruction in the track of the lymphatic vessels.

The inflammation ceases at the nearest gland. This is a fact abundantly exemplified both in the simple and the specific inflammation of absorbents. The known situations of the superficial glands are those towards which inflamed absorbents may be traced, and at which their inflammation culminates to its highest degree of severity, and is almost invariably extinguished. The gland appears to arrest the free progress of the acrid lymph, itself becoming inflamed. Sometimes the current of

¹ Greenhow, *On Diphtheria*, p. 196.

² Cruikshank, *On the Absorbents*, p. 76.

morbid lymph through it is completely stopped; at other times it gives passage to the lymph, or itself supplies morbid material to the higher absorbents and the circulating blood. Even in that case, however, the higher glands do not inflame or suppurate. Did they do so, we should commonly see abdominal abscesses, peritonitis, &c., in primary syphilis, and inflammation in the neck combined with traumatic suppuration in the armpit. The inflammation of a gland, which is excited under these circumstances, may vary from a slight increase in its size and firmness, with some tenderness, to a degree of severity which issues in extensive suppuration. The gland in the former case may be felt rolling in the tissues, almost as readily as in health, and its tender and swollen state outlasts the inflammation of the afferent lymphatic vessels by a few days. It may, however, enlarge to twice or thrice its natural size, and continue swollen and tender for two or more weeks. This is especially noticeable in the case of a gland near the femoral ring; the tenderness, tension, even surface, and position of which sometimes cause it, when recently inflamed, to be mistaken for a strangulated hernia, especially if at first there should concur with its inflammation some nausea and constipation. Or, further, the gland may suppurate. This event may not ensue until a week or more after the inflammation of the lymphatic vessels has passed away. It is sometimes indicated by a renewal or increase of the local pain, and by rigors and other constitutional symptoms. But not at all unfrequently suppuration occurs in a gland without any local symptoms which attract notice. The first pain attending the inflammation having subsided, a patient may be unconscious of any disease in his armpit, while matter to the extent of half a pint or more may be collecting there and behind the pectoral muscle. Suppuration is rarely limited to the area of the gland. The suppurating structure is rather the loose areolar and adipose tissue in which the gland is embedded, and which here, as elsewhere, is observed to suppurate with a less degree of inflammation than that which already exists, without exciting suppuration, in the inflamed organ. Abscesses connected with inflamed glands may therefore reach any size which their position allows; they are, for instance, prone to be larger in the loose tissue and spacious area of the axilla than in any other region occupied by superficial glands. The matter discharged from them is thick and well formed; and after it and any slough which may have been produced by the intensity of the inflammation have been evacuated, the cavity closes. Usually an abscess in the armpit or groin soon heals, but sometimes, when it has burrowed far beneath the fascia, and in the popliteal space, the cure is slow.

Inflammation and suppuration of the glands appear to be eliminative as regards the afferent lymphatics and the injured distal parts, and protective as regards the circulating blood. During the continuance of suppuration in the axilla, the activity of inflammation in the distal parts subsides, as gonorrhœa is often temporarily suspended so long as the bubo is forming or freely discharging.¹ On the other hand, the poison which has reached a gland by way of the lymphatics does not pass beyond it. When, however, a cutaneous pustular eruption comes out on the trunk, or severe constitutional symptoms, like those of pyæmia, arise, it is clear that the morbid poison is not limited by the gland in the manner supposed. Of the various hypotheses by which these occurrences may be explained, those seem most consistent with the anatomy and the other diseases of the absorbent system, which assign the pustular eruption to the anastomosis of minute cutaneous lymphatics, and the infection of the blood to the glandular suppuration itself. In the former case, the poisonous matter which is held back by the suppuration traverses the collateral channels, and produces pustules wherever it filters over the vast area of skin subordinate to the obstructed glands. In the second case, the matter from the gland itself is assumed to find a passage along the efferent lymph-tubes into the blood.

The constitutional symptoms attending an attack of acute angeiolecitis are

¹ 'Ubi pestis minus sevo morsu lacessit, in molliores decumbit glandulas, quæ ad corporis superficiem prominent; quales sunt inguinales, axillares, &c. Si convalescere datur ægro-tanti, tumores ii, uti in variolis, legitimam nanciscuntur suppurationem, morboque naturam hæc via exonerant.' (Mead, *de Curatione Pestis*.)

sometimes severe. Rigors, nausea and vomiting, heat of skin, thirst, dryness and coating of the tongue, with constipation, sleeplessness, and considerable nervous agitation, a quick bounding pulse, and a feeling of languor, are usually the severest accompaniments of the disease. If the fever be typhoid, if there be profuse foetid sweats, severe muscular pains, high excitement, a dry burning heat of skin, and marked delirium, the poison is no longer limited within the lymphatic channels, but has infiltrated the cellular tissues, and has tainted the blood.¹ As the inflammation subsides, and local suppuration, a cutaneous eruption, or foetid discharges from the bowels, come on, the general symptoms become those of exhaustion.

The cases depicted in the foregoing description are those of considerable but of ordinary severity. There is much variety in this respect, however, in different cases. There may be a mere passing soreness, with some enlargement and hardening of a gland, whilst the intermediate lymphatics between the wound and the gland have either not inflamed or been so little irritated that no pain or inconvenience had been felt in them. A hard cord may be felt beneath the skin, leading to a tender swollen gland, but there may have been no red lines, and there may be no suppuration. There is sometimes an axillary abscess without the previous occurrence of red lines, and the latter may form without occasioning any axillary tenderness. Sometimes the track of the absorbents is tender for a day or more before the red lines appear, but more commonly they are amongst the earlier symptoms of the inflammation. In a case in Mr. Moore's practice red lines appeared twice between the wound and the armpit. No suppuration took place in the inflamed gland, but a pustular eruption over the trunk seemed to show that some poison which had passed the gland was being eliminated by the skin. In another case the absorbents inflamed without occasioning the linear redness on the skin, and three abscesses formed in the axilla. There was in this case no cutaneous eruption. When suppuration occurs, it most commonly does so only in the gland; but it may take place in the absorbent tract, without involving the gland, or may affect both the vessels and the glands. In the later progress of the severer cases additional symptoms and pathological changes may result from particular constitutional tendencies of the patient. Thus inflammation of the absorbents of the arm has been known to terminate in fatal acute œdema of the tongue, the absorbents being infiltrated from the thumb to the submaxillary gland.

Simple traumatic inflammations of the absorbents prevail in particular localities. They are very much more common in the arm and axilla than in any other parts of the body. A similar observation has been made respecting plague, and the reason in both cases appears evident. The hand, from which these inflammations originate, is at once more liable to injury, and, except the face, more exposed than the rest of the surface. Glandular suppurations in the mesenteric, lumbar, and bronchial glands are as small as they are rare, and only some of the cases of iliac and pelvic abscesses following upon parturition are to be compared in extent with those in the armpit. In one situation glandular suppuration calls for an especial notice, viz. at the lower part of the left side of the neck. A severe and deeply-seated acute abscess is apt to form in that situation, and, as it is bound down by the fasciæ and platysma of the region, it may continue long without finding an outlet. It occasions great swelling,

¹ See ERYSIPELAS, ANIMAL POISONS. It is these severe and rapidly fatal cases which some authors (*e.g.* Bradley) propose to separate from ordinary angeioleucitis, and describe as a class by themselves under the name of 'septic angeioleucitis.' I can see no proof that the morbid action, or the mode of propagation of the disease, differs in the cases in which a putrefying material is known to have been inoculated, and in those ordinary cases in which there is no such proof. For instance, a butcher pricks his finger with his skewer, and inflammation of the absorbents follows. Can any surgeon tell from the symptoms or appearances whether the meat was putrid or no? Or put the same case the other way. A student pricks his finger in dissection. Though the matter inoculated is highly putrid, is it not quite a common result (in fact, far the most common) for him to have the simplest form of angeioleucitis? Mr. Bradley, in trying to establish a specific difference between 'septic' and 'aseptic' diseases, is obliged to class erysipelas as 'septic,' and hence to deny the appellation of erysipelas to all those numerous cases which obviously have no contagious origin, and exhibit no contagious properties. These he is obliged to class as 'erythema,' though they are absolutely identical with the others in all clinical features.

œdema, tension, and pain. The root of the neck is much raised by the swelling, and the clavicle hidden. In all the cases which Mr. Moore met with, the abscess was on the left side of the neck, involving the whole region of the cervical part of the thoracic duct, and not extending into the axilla. The cause of these great and severe suppurations is sometimes obscure, and they may not always originate in disease of the lymphatics; but sometimes such a mode of origin does appear, and in one of Mr. Moore's cases an enlarged tender gland was described as having been first felt. It should also be remembered from how many parts lymphatics converge towards the left side of the neck. In some of these cases, though it seemed clear that suppuration had occurred, no external discharge of the pus took place.

Inflammation of the lymphatic glands, *adenitis*, sometimes occurs alone, *i.e.* without any previous perceptible inflammation of the afferent vessels. It does so after some of the fevers of childhood. The higher cervical glands are then very liable to swell and become painful. Being in the neighbourhood of the lower jaw, tongue, and pharynx, all movements of these parts are restrained, and a good deal of suffering attends mastication and swallowing. Such cases of adenitis follow scarlatina, and are sufficiently explained by the state of the throat. These cases are not to be confounded with those of true cynanche parotidea. An absorbent gland in the centre of the parotid may inflame as lymphatics inflame elsewhere, but its disease does not produce the characteristic, contagious, and metastatic affection commonly known by the name of mumps.

Treatment of inflamed absorbents.—Many of the ordinary duties of life expose persons to this painful affection; and it often arises in circumstances to which busy manual labourers pay no attention. Soaking fresh cuts in Burnett's fluid, or the application of collodion upon a small wound or puncture, or of court-plaster upon a longer wound, might avert many of the attacks of inflamed absorbents.¹ When patients with wounds of any kind are under medical advice, the common precautions of cleansing the wound, securing the proper action of the purifying organs, and avoiding unhealthy diet, air, and occupations, are enough to prevent such attacks. Upon the occurrence or threatening of an inflammation of the absorbent vessels, the wound may be soaked in undiluted sulphurous acid, a measure which has been found to arrest suppuration near the finger-nail, produced by an animal poison, and already beginning to infect the lymphatics. The wound should in all cases be thoroughly cleansed. It should be opened, put under a stream of water, syringed, or soaked in a thoroughly hot bath, as may best suit its form and condition. If recent, or punctured, it should be sucked, and then touched throughout with a stick or pencil of nitrate of silver. If flabby, it should be stimulated with a suitable mineral lotion. If fetid, it should be wrapped in solutions of Condyl's or Burnett's fluid, or in chlorinated lotions. If sloughy, it should be covered with Peruvian balsam and a poultice of linseed meal, charcoal, or beer-grounds. Heat is in all these cases grateful to the patient, and if often changed, in order to secure the cleansing of the wound, a poultice will generally be found the best local application.

The lymphatics themselves are best treated by the nitrate of silver. It should be wiped a few times on the moistened skin along the red or tender lines. Care should be taken not to apply it too freely, as the subcutaneous inflammation can be as effectually moderated by blackening the skin as by blistering it. After soaking and applying caustic, the surgeon may wrap the limb in cotton-wool, and enjoin complete rest.

The glands in the early stage may not have shared the inflammation, yet the nitrate of silver may be applied over them also, and the use of it should in all cases be carried higher than the tenderness and redness of the surface. The removal of all further irritation from the wound, and moderating the inflammation of the lymphatic vessels, will in most, but not all, cases secure the patient from suppuration in and

¹ The practice of smearing the hands with glycerine, vaseline, or oil before touching noxious fluids is found to prevent the mischiefs which might arise from absorption, and is of great value at post-mortem examinations.

near the glands. If further means appear requisite for this end, they may be found in leeching, and the application of ice or a cooling lotion to the surface. Cold, however, does not seem adapted to arrest threatened suppuration in glands. Heat is commonly more grateful to the patient than cold in such cases. It may be employed in a bath or in the form of steam. The latter may be directed from the spout of a kettle against the tense and painful part by means of a paper tube. If the inflammation continue, mercurial ointment is also useful; it should be laid not only over the gland, but along the track of the previous lymphatic inflammation, which has already indicated the natural channel for absorbed remedies to reach the inflamed gland. It may be observed, however, that in not a few instances, when once the glands have inflamed, no treatment averts suppuration, and special attention must always be directed to them for a week or two after the first inflammation, in consequence of the occasionally insidious progress of abscess after adenitis. When acute glandular abscess is advancing to the surface, and occasioning much pain, it should be opened. But, if there be any reason against this treatment, much relief to the suffering, and some acceleration of the pointing, are obtained by leeches. From one to three leeches are quite enough for this purpose; a larger number would have the effect of retarding and diffusing the suppuration. In like manner the slow progress of a chronic abscess of glands may sometimes be quickened by the application of a small blister upon the prominent part of the swelling.

The treatment in the lymphatic inflammations of convalescents is chiefly that which will relieve the pain and guard against the somewhat rare event of suppuration. Steam, followed by an application of cotton-wool, ordinarily serves this purpose, and pure air, without draught, is also of much importance.

Hypertrophy and atrophy of glands.—One of the first facts observed in studying the lymphatic system is, that in disease, and still more in health, its condition varies with that of the tissues from which its vessels spring. So far as age defines the activity of growth and nutrition, the glands vary with it. They are proportionally larger in children than in adults, and in these than in persons advanced in life. But with premature emaciation of other tissues, glands also waste before their time, and they have been found larger in a well-nourished woman at ninety years of age than in one who at fifty had died exhausted by chronic disease.¹ In wiry, slender people the glands are small and firm; they are succulent and large in persons characterised by softness of fibre, a thin fair skin, and some embonpoint. Even in the same body the lymphatics differ from one another according to the tissues with which they are associated, the structure or functional activity of the primary organ entailing some corresponding variation in the texture, the size, and even the number of the subordinate lymphatics. There is, for instance, less glandular structure in the course of the absorbents of one of the lower extremities than of one of the lungs, great as is the difference in the bulk of those parts. The largest of all the absorbent vessels are those found in connection with the uterus at the period of parturition. And as in size and number, so are there differences in the texture of various lymphatics. 'The glands of the thigh or arm will sustain a large column of mercury without bursting; whilst the glands on the mesentery, or on the lumbar vertebræ, easily burst.' For 'these last resemble the viscera of the abdomen and thorax, whose texture is much more delicate and tender than that of the external muscles.'²

The transition is imperceptible from an hypertrophy or enlargement of glands, which corresponds with the state of the tissues, to one which is strictly morbid; and in practice it is scarcely to be defined. A general fulness of all the glands concurs in some persons with rickets, a large brain, and a hypertrophied thyroid gland. In other cases, the large succulent glands, which are met with in children of soft loose fibre, seem readily to receive the yellow deposit of actual disease.

Lymphadenoma is the name which is now generally given to a disease of which the first description was given by Dr. Hodgkin in the seventeenth volume of the 'Medico-Chirurgical Transactions,' and which is very commonly called after his name,

¹ Gulliver's *Hewson*, Sydenham Society's edition.

² Cruikshank, *On the Absorbents*, p. 71.

'Hodgkin's Disease.' It is characterised by a painless enlargement or hypertrophy of numerous absorbent glands, sometimes in one region (and then usually in the neck), sometimes in many different regions of the body. The enlarged glands increase in size usually without any pain, suppuration being hardly ever noticed. Sometimes this enlargement attains an enormous size, and affects most of the glands of the body. The internal organs are often affected, the spleen more commonly than any other organ, but the lungs, liver, kidneys, and other internal viscera¹ also often suffer. The pathological anatomy of the affected parts appears to the naked eye to be a simple hypertrophy in the glands. The enlarged glands, if removed at a surgical operation, and cut across, present a uniform homogeneous greyish or yellowish colour, and are usually of about the consistence of healthy glands, though sometimes much softer. If examined with the microscope, much of the trabecular structure of the gland is found to have disappeared, and to be replaced by a congeries of lymphoid cells. In this way the natural structure of the gland is destroyed, and nothing is left ultimately save a mass of lymph-corpuscles, permeated by almost invisible fibres of connective-tissue and capillary vessels. Similarly in the viscera and other organs (such as the lungs, liver, or mesentery) the essential feature in the disease appears to be the production of lymph-corpuscles in enormous numbers in the sheaths of lymphoid tissue which naturally enclose the vessels of the part.² By this effusion the proper structure is replaced, encroached upon, and finally either atrophied or converted into a fibroid mass by the new production.³ To the naked eye this deposit is either diffused as a greyish layer over the parenchyma, or aggregated in tubercular masses.

The symptoms of this disease are very obscure at first. All that is noticed is an indolent swelling of the glands, very commonly of the neck, not due to any discoverable irritation in the region of the affected glands,⁴ and in many cases succeeded by similar enlargement of the glands of other and possibly remote parts. The first definite symptom is probably debility caused by anæmia, and the patient generally sinks very gradually from slowly increasing exhaustion. But in other cases there are more definite symptoms, either those of leucocythæmia or of phthisis, or pressure-effects from the growth compressing the trachea, the large blood-vessels, or other important parts. Frequently also the patient falls a victim to some intercurrent disease; 'indeed, so commonly does this happen,' says Mr. Messenger Bradley,⁵ 'that pleurisy, thrombosis, Bright's disease, pneumonia, and erysipelas must be regarded as complications of the disorder.'

The pathological process in which the disease originates is still obscure; but there can be no question that the symptoms are due to a change in the composition of the blood, whether that be regarded as the cause or the effect of the anatomical degeneration of the lymphatic system. In some cases (those in which the spleen is affected) the blood presents an absolute increase in white corpuscles, in others it is merely diluted, as it were, 'like weak claret,' from a decrease of the whole corpuscular element. This alteration in the mass of the blood appears to me to be the cause of the debility, and to be the occasion for the frequent invasion of intercurrent diseases.

The diagnosis seldom presents much difficulty. The absence of any visible exciting cause, the non-inflammatory nature of the swelling, and the invasion of different groups of glands at the same time, are features which this disease has in common with no other, unless it be strumous affection of the glands. And no doubt in some cases, in which the disease has not yet shown itself in other than a single

¹ The medullary tissue of the bones has been found to be invaded by the disease, and a case is recorded (*Path. Trans.* xxv. 246) in which the testicle was affected.

² A good drawing of this condition is in the *Path. Soc. Trans.* vol. xx. p. 196, pl. viii. fig. 2.

³ 'Fibroid phthisis' is often, at any rate, of this nature.

⁴ Trousseau is of a different opinion, and believes that in a large proportion of cases the disease is provoked by some local irritation. See Trousseau's '*Clin. Med.*' *New Syd. Soc.'s Trans.* vol. v. p. 207.

⁵ *Inj. and Dis. of the Lymphatic System*, 1879, p. 116.

region, and where the patient is young, it may be impossible to pronounce a decided opinion without watching the case for some time; but these are the exceptions, and even here, the different course of the two affections, the absence of the tendency to suppuration, so marked in strumous glands, or of any other strumous affection, will soon distinguish lymphadenoma.

Prognosis.—I do not take quite such a gloomy view of the prospects of this disease as that which is commonly entertained. While fully admitting that the disease when widely spread and affecting many chains of glands, and still more the internal viscera, is incurable by any known treatment, and tends inevitably and sometimes speedily to death, I still think that I have seen several instances of complete recovery, under medical treatment, in early stages of the disease, and I regard the performance of surgical operations for the removal of the affected glands as a justifiable experiment, though the good results of such operations have yet to be proved. In these views I am glad to see that the latest writer on the subject, the late lamented Mr. M. Bradley, concurs. This writer gives one case under his own care, and refers to others reported by M. Hipp. Larrey, as showing the justifiability and occasional good results of the removal of the affected glands in the early stages of the disease. My colleague Mr. Haward published a case in the '*Clin. Trans.*' (ix. 40), in which he cleared out the whole side of the neck at two operations. The disease recurred, but the child was at least temporarily relieved; and it is possible that had the operation been performed earlier, it would have had more complete success. I recently assisted him at a similar operation, and the progress of the case was favourable for a time. Yet it must be allowed that up to the present time the proceeding is an experimental one, that it is often exceedingly dangerous, and that after all it is very difficult to remove all the affected glands. In the case just referred to, the sterno-mastoid was cut across, and the whole neck, from the jaw-bone to the subclavian vessels and pleura, completely cleared out. Yet it was almost certain that some slightly enlarged glands were left under the clavicle; and although the operation was followed immediately by marked improvement in the general health, yet in a few months the disease recurred, and the child did not long survive.¹

In cases where the enlarged glands are causing local pressure there need be less hesitation as to the propriety of their removal.

The general treatment of this disease, from which I have seen most benefit, has been a course of iodine, in moderate quantity, gradually increased and continued over a long period of time. Mr. Bradley speaks highly of a solution (alcoholic or ethereal) of phosphorus in doses of 1-50th to 1-15th of a grain twice or thrice daily. Other observers have found benefit from arsenic, and there are of course cases in which cod-liver oil and iron, though they can have no specific influence, are yet indicated by the general debility. It is superfluous to say that all hygienic imperfections should be corrected.

When these cases are excepted, and those which are referred to in other parts of this essay, there are few slow enlargements of the glands left which can be assigned to mere chronic inflammation. Some such cases, however, inasmuch as they yield to a mild mercurial course, are assumed to be of that nature. The case had need be very clear which could admit of such treatment; but the fact of its occurrence justifies the treatment in cases which are unmarked by constitutional disease, or which do not yield to the milder measures recommended for the treatment of scrofula. The mercury should be prescribed in small doses, and be combined with some tonic. Quinine and calomel, the bichloride of mercury in decoction of bark, the biniodide of mercury in

¹ A preparation in the Museum of St. George's Hospital (Ser. x. No. 15) shows a chain of cervical glands affected with lymphadenoma removed by Sir B. Brodie, possibly before the disease had been described by Hodgkin—at any rate, without any reference to his description, or any diagnosis of the nature of the enlargement. It is merely said that many remedies had been employed unsuccessfully in the treatment of the disease, and that the boy completely recovered from the operation. Dr. Ogle adds (*Path. Trans.* xi. 255) that, as far as was known, no other enlargement of glands existed or appeared afterwards.

the form of a pill, and calumba, cascarilla, quassia, or sarsaparilla—any such combinations may be adopted. The state of the glands in cases of rickets rarely rises into importance as compared with the other disease. When it does so, it is chiefly on account of suppuration taking place in them, with every indication of a strumous character. Local treatment may go on at the same time; ointments or washes of lead, iodine, opium, or of combinations of these remedies, being continuously applied. Blisters are to be avoided in glandular inflammations. They necessarily irritate the lymphatic vessels of the skin, and tend to aggravate, rather than moderate, an existing inflammation. A leathern plaster left constantly on the surface is more effective in reducing the swelling, and it may be medicated in any manner suitable to the case; the various emplastrs of the Pharmacopœia affording choice enough for that purpose.

The *strumous* and *syphilitic* affections of the lymphatic system being fully treated in the articles on those subjects, nothing more is needed here than to refer the reader to those essays.

Lymphatics in cancer.—For facts connected with cancer in the glands, reference may be made to the essay on that subject in vol. i. Some additional remarks bearing on diagnosis will be found in the section upon the state of the *glands in innocent diseases*.

An absorbent gland infected with cancer may contain the minutest speck of the disease. Mr. Moore once found under the microscope in epithelioma a single small spot of characteristic cells in a whole field of perfectly healthy glandular structures. But it often entirely ceases to be a gland at all. The whole structure is replaced by cancer. In certain situations the disease extends to all adjoining tissues, and involves and destroys all the glands of the region. Secondary cancers in the groin, for example, following primary disease of the penis or vulva, may thus exterminate all the inguinal lymphatic system, and, when they ulcerate, may give an outlet for a copious discharge of lymph. In such a case there may be not only considerable œdema of the foot and genital organs, due to the hindered circulation of the lymph, but a wasting also, and in one instance an almost complete conversion into fat of glands in the lumbar region, as if their function had been lessened or abolished by the isolation of the lower limb. Far more commonly the rule is observed that cancer reproduced in the lymphatics becomes diffused throughout the system.

Cancer of the lymphatic glands is rarely difficult to recognise. Some primary tumour claims the chief attention, and determines the nature of the secondary affection. When the glandular disease so far exceeds that of the primary tissue as to be first observed, it may be distinguished to be scirrhus, sometimes by the contracted shot-like tumours to which the glands are first reduced, sometimes by their being enlarged, sometimes by their being clustered together into an irregular tumour. The characteristic hardness of scirrhus is more commonly noticed in the first case, since, when scirrhus occupies but a part of a gland, the remainder of it may swell and cause the whole to feel comparatively soft; and when it occupies one or more entire glands and grows beyond them, the whole tumour is stony only so long as degenerative softening in it is delayed.

The first occurrence of cancer in a gland may take place quickly or late after the formation of the primary tumour. In some instances the secondary disease is even observed first; in others the lymphatics escape infection altogether. Upon what these various facts depend is not known, but it is interesting to observe that they have their parallel in the pathological actions of the lymphatics after the insertion of a poison into the body. Sometimes they inflame with great rapidity, and sometimes they are not affected at all. Sometimes their inflammation is delayed, and in the case of the inoculation of small-pox it is not until the seventh day that the glands inflame. The advance of cancer to the glands, and its commencement in them, are almost invariably unnoticed; but in one case of primary and still un ulcerated cancer of the hand, the absorbents were first affected with inflammation, red lines suddenly arising on the skin, and a gland enlarging, which soon assumed the

character of cancer. The patient was a well-grown womanly girl of fourteen, and the disease of a medullary nature, and extremely rapid in its progress.

When once established in a gland, cancer usually pursues its course like any other secondary tumour. It may attain a very moderate or a vast size; it may be stationary, or may wither; it may appear dependent or independent on the primary growth or on the growth of other tumours in the body. These facts are sufficiently stated in the article on CANCER. It may be added, that no cases of an universal tainting of the lymphatic system with cancer are observed, as is sometimes the case with tubercle. Cancer appears to travel along the absorbents in a manner which is explicable by the anatomical arrangements of those vessels, and not to affect the system as a whole.

The glands in innocent diseases.—Lymphatics appear to have no special relation to the functions of the several parts with which they are connected. Organs having only blood-vessels, and those provided also with an excretory duct, equally possess a system of absorbents. The glands may therefore be said to be appended to the tissues, as such, and may be expected to vary with those tissues in their condition. That they do thus vary within the limits of health has been already stated in the section on *hypertrophy of glands*; and the probability is that they are consecutively altered by every morbid variation in the condition of the tissues.

In practice, however, such morbid variations are not appreciable, unless they cause a change in the size, form, or density of the glands. So far as surgery is concerned, glands not appreciably affected pass for being healthy.

The importance of the question as to the state of the glands in various diseases is shown by the general facts already alleged as to their implication in cancer, in contrast with their relation to tumours which may be classed as not malignant. Although at the commencement of cancerous growths the glands are rarely affected, yet they are sometimes both early and most extensively diseased, and at some period before death they are almost always invaded. Even the bony substance of osteoid is reproduced in the glands. An affection of the lymphatics by any innocent tumour, on the contrary, in the same sense in which they are involved in cancer, is very rare, probably as rare as the case of glands unaffected in that disease. They may indeed be enlarged in connection with an innocent tumour, but it is because irritation of the skin or ulceration likewise exists. Such enlargement is a transient inflammatory swelling, not a reproduction of the primary disease in the gland, and is no more to be ascribed to the presence of the tumour than if none existed.

Reserving such cases, I may enumerate the following diseases in which no appreciable affection of the lymphatics is observed: all simple hypertrophies of any organ or part, and all tumours which present some likeness to the structure in which they are formed. Fibrous tumours of the uterus and prostate, therefore, mucous polypi, chronic mammary tumours, cutaneous thickenings and mollusca, adipose tumours, and exostoses, with other growths of the same character, are unattended by the development or repetition of the disease in the glands. If cysts should co-exist with malignant tumours, the glands may be affected with cancer; but cysts, as such, and cysto-sarcoma, are never followed by corresponding disease of the lymphatics. This fact is observed in the ovary, the os uteri, the kidney, the subcutaneous structures, the spermatic cord, sometimes in colloid, and, what is of the greatest practical importance, always in the female breast.

Mr. De Morgan¹ had under his care a middle-aged woman, whose left breast was the seat of an enormous innocent tumour, and the right of a well-marked scirrhus growth. The former tumour, growing rapidly, and threatening the patient with speedy death, was removed, and was found to be mixed cystic and adenoid, copiously infiltrated with cells and nuclei. The right axillary glands were extensively cancerous; yet even with cancer thus existing in the body elsewhere, the glands in the left axilla were healthy.

Some tumours, composed of structures unlike the part in which they grow, are

¹ *Pathological Transactions*, 1868, p. 394.

not attended by disease of the same kind in the glands. Enchondromata of whatever size, whether occurring in the bones or elsewhere, are not usually attended with disease in the lymphatic system. Sir J. Paget met with an exception to this rule of exemption of the lymphatics from secondary cartilaginous infection, in a case of enchondroma of the testis.¹

Fibrous, fibro-cellular, and fibro-nucleated tumours, do not affect the glands; but when, though not adopting the structure of malignant disease, they assume its clinical character, they may in their dissemination involve the glands. In sarcomatous tumours glandular implication, though not unknown, is rarer than in those which are truly carcinomatous. Chronic abscesses in the substance of organs, such as are sometimes confounded with more important tumours, do not occasion an enlargement of the glands. An hydatid cyst may be covered with extremely large lymphatic vessels, yet occasion no disease of the subordinate glands. In an instance of a tumour in or near the female breast, which contained echinococci, and which had been suspected to be of malignant nature, the glands were entirely free from disease. A considerable enlargement of the inguinal glands took place in the course of a case of extremely rough osteo-arthritis of the hip-joint, and was attended with œdema of the limb. The intercurrent glandular affection subsided during prolonged rest. In another case the shoulder-joint was affected with the same disease, and enlarged glands in the neck for a considerable time simulated a subclavian aneurism.

Pyæmia is not necessarily attended with inflammation of lymphatics, but there are a few general diseases in which those parts do share. These only of them, in addition to those which form the subjects of the present essay, may be mentioned: variola, vaccinia, typhus, plague, hydrophobia, glanders, and farey. I would add a few remarks upon ulcers and erysipelas.

Ulcers.—The glands above old ulcers are often found enlarged, and, on some occasions, tender; but they rarely need attention, and little, if anything, is known of the results to the glands from chronic ulcers of the bowel or uterus. When an ulcer, however, is situated near or connected with any form of tumour, enlargement of the glands, though only such as may attend any ulceration, may give to the case the semblance of cancer. No conclusion as to the cancerous nature of such an ulcer should be formed upon the ground of co-existent disease of the glands, without considering the amount of irritation of skin, and the character of the ulceration. By rest, a proper posture of the ulcerated part, and appropriate soothing or other treatment, such enlarged glands will often subside. This has been known to occur when the ulcer existed over a vast cysto-sarcoma of the female breast, and even when the primal irritation was an inflamed state of common carcinoma of the mamma. On the other hand, cancer does sometimes come on in a chronic ulcer, and then produces a very great enlargement of the glands.

Erysipelas.—The exanthemata which extend over the whole integument of the body, as scarlatina and rubeola, do not perceptibly affect the lymphatics; but almost all limited inflammations of the skin are accompanied with some degree of tenderness or painful enlargement of the glands of the part. After blisters, upon the irritation arising from many surgical applications to the skin, in urticaria, in the cutaneous inflammation following an ordinary bruise, it is often met with, but it is most frequent in erysipelas. When that disease arises on unbroken skin, adenitis is an early, although a slight, symptom, and little noticed in comparison with the primary cutaneous eruption. But when erysipelas originates at a wound, the glands are sometimes swollen and tender before any blush can be discovered on the skin. They are stated to have been found red in an enteritis, which was recognised as erysipelatous;² and the almost invariable occurrence of adenitis at the commencement of the disease goes far to support the opinion, that the first inflammation of erysipelas is in the lymphatic system. In all cases except those treated of in the section on ‘Inflammation of the Absorbents,’ the glandular affection is transient, and requires no special treatment.

¹ *Medico-Chirurgical Transactions*, vol. xxxviii. p. 247. ² *Gazette médicale*, juin 7, 1856.

Morbid contents of lymphatics.—Since it is a part of the healthy function of the absorbent system to receive the matters discharged into its radicles by the tissues, it happens that in disease also morbid substances find their way into it. Pus is frequently seen in the absorbent vessels of the pelvis in cases of fatal uterine inflammation. It was found, too, by Dr. Bright in tortuous lymphatic vessels, as large as iliac arteries, on the walls of a vast hepatic hydatid cyst.¹ Virchow² found still remaining in an axillary gland some cinnabar, which had been inserted by tattooing in the skin of the arm fifty years before death. Similar but less remarkable facts have been long known. Lapidaries have the lymphatic glands near the bronchi filled with earthy concretions, which are supposed to consist of inhaled stone-dust. Poncey saw the thoracic duct and its glands full of a cheesy substance. Perhaps the most common morbid material met with in this system, excepting strumous and cancerous matter, is some form of chalky concretion. Large masses of it may be found even in young subjects, whose glands have probably been early affected with scrofula. Assalini found it in the thoracic duct. Scherb saw a calculus in the same canal, and took it to be the cause of a dropsy. Cheston observed a thoracic duct so filled with bony matter, which had been absorbed from a spina ventosa of the ilium, that air could not be blown through it.³ Some glandular chalky concretions in a young pig are stated by Vulpian to have been found tinted by madder, with which the animal had been fed.⁴ Finally, it is asserted that worms have been discovered in human bronchial glands, as well as in the glands and absorbent vessels elsewhere.⁵

Obstructions and obliterations of the lymphatic vessels.—When Sir Astley Cooper tied the thoracic duct in the necks of some dogs, the receptaculum chyli burst, and a copious extravasation of lymph took place. A similar result was once observed in the human subject to follow a more slowly formed obstruction by disease,⁶ a fatal peritonitis ensuing upon the escape of lymph through the rent into the peritonæum. The Museum of Guy's Hospital contains a specimen of a lacteal larger than a pullet's egg behind a diseased mesenteric gland. In the same museum is a thoracic duct completely compressed at its upper extremity by cancerous cervical glands. The duct is not at all dilated; but as there is another mass of cancer in its immediate vicinity near the pancreas, it is not improbable that the influx, as well as efflux, of lymph through it was hindered. Mascagni, attempting to inject some pulmonary absorbents, found the bronchial glands so obstructed that the mercury rather burst the vessels than traversed the glands. Sömmerring, without accounting for it, relates the instance of a robust woman suffering from ankylosis of the knee, in whom the absorbents of the thigh were varicose, and so tensely filled that, upon being pricked, their fluid contents spirted violently forth, and that the foot was affected with a kind of œdema.

A *varicose* condition of a lymphatic vessel may possibly arise from another cause than its obliteration, contraction, or compression. There may be a regurgitation at the upper orifice of the thoracic duct, or there may be an accidental communication between an absorbent and a blood-vessel, an arterio-lymphatic or a veno-lymphatic aneurism. Such a case might be that of a thoracic duct, figured but unexplained by Cruikshank, in which the vessel is greatly enlarged and tortuous. Its diameter is nowhere less than four times its natural size, and, being increased in length as well as in calibre by the great power or weight of the stream within, it lies in many closely adjoining loops, which stretch to and fro across the vertebræ.

The excision of glands is not a favourite nor a very easy operation. I have already expressed my opinion that it is justifiable in the early stages of lymphadenoma, but I have also pointed out its dangers and the difficulty that there is in

¹ Guy's Hospital Museum.

² *Cellular Pathology*, translated by Dr. F. Chance, p. 185.

³ *Phil. Trans.* vol. lxx. part ii. p. 323.

⁴ Potain, *Lésions des Ganglions lymphatiques viscéraux*, p. 33.

⁵ Davaine, *Traité des Entozoaires*.

⁶ Dr. Cayley's case of Obstructed Thoracic Duct; Rupture of the Receptaculum Chyli; Peritonitis. *Path. Trans.* vol. xvii. p. 163.

cleanly removing all the affected glands. And in cases of cancer, where it is often necessary to excise glands (especially in the axilla and the groin), much difficulty and often very serious embarrassment will be experienced, in consequence of the disease having spread to deeper glands than those which were known to be affected before the operation. Strumous glands are more rarely made the subjects of operation. In fact, it is only under exceptional circumstances that the attempt is justifiable.¹

In all such operations, the best precaution consists in making a very free external incision, and conducting the operation with the greatest deliberation. The operator must be prepared to find large vessels glued to the cellular tissue supporting the glands, only recognisable by minute search, and only controllable (if divided) after complete exposure. In the case of cancerous glands, the surrounding structures ought to be freely removed. It is not sufficient merely to shell out the glands. No such necessity exists, however, in lymphadenoma; so that a large mass of glands may be removed from the neck or axilla with comparative facility. Still, any surgeon who has had experience of the numerous dangers that beset extensive dissections among large arteries, veins, and nerves, will agree that the freest possible incisions afford the best security to the patient.

CHARLES H. MOORE, 1870.

TIMOTHY HOLMES, 1882.

¹ On this subject, consult the essay on SCROFULA.

DISEASES OF ARTERIES.¹

ACUTE ARTERITIS.

THIS is a rare disease. The most distinct instance of a limited arterial inflammation is that of the umbilical arteries, which after the ligature of the funis are sometimes filled with pus.

Inflammation of the aorta appears to have occurred in the practice of some physicians, and to have been traceable to the influence of cold. One such instance in Dr. Goodfellow's practice followed upon a young man's lying for a long time upon his chest on wet ground. But most of the cases formerly described by surgeons as primary inflammation of arteries appear, by the light of later research, to have been due to the previous impaction of a plug. Inflammation of an artery, and even suppuration, may then take place, but it is a secondary disease, and it will be referred to in the section on 'Occlusion of Arteries.' Upon many of the cases in which long portions of artery are found obliterated and converted into fibrous cords, it may suffice to say that no evidence of previous arteritis or of any cause whatever can be adduced, and that the same result without obvious inflammation attends the obliteration of the ductus arteriosus, and sometimes follows the application of a ligature. In other instances, however, we may allow that the pain and tenderness which were experienced over the course of the obstructed vessels pointed to an inflammatory affection, for which there was no apparent cause in any previous obstruction of the artery; and in one case, which I had myself the opportunity of seeing, and which is recorded by Mr. J. H. Morgan in 'Clin. Trans.,' xiv. 183, there were very striking symptoms of inflammation in the course of various arteries with no obstruction whatever. I am not therefore disposed to deny the existence of acute and subacute arteritis, though the majority of the cases so denominated are susceptible of a different interpretation. Beyond local and general sedatives no treatment seems possible.

CHRONIC ARTERITIS.—ATHEROMA.

Atheroma, or the pulpy degeneration of the wall of the artery, was originally described by Gulliver as a process of fatty change. Mr. Moore, in the former editions of this work, regarded it as originating in a deposit out of the arterial blood on the lining membrane. It is now, however, generally believed to owe its origin to chronic inflammation, situated either in the deeper layers of the inner coat, or perhaps in the internal and middle coats of the vessel.

This view, which is supported by Virchow and other Continental pathologists, has been advocated with conspicuous ability by Dr. Moxon,² and may now I think be accepted, without any prejudice to Gulliver's view, or to the accuracy of his description. That the softened pulpy spots in the artery are formed of fatty matter is indisputable; but I think we must allow that it is equally clearly proved that they are preceded by the increased cell-production characteristic of inflammation. According to this view, then, the initial stage in atheroma would be inflammation and cell-proliferation in the tunica intima and media. This is followed by fatty

¹ In revising this article, I have transferred Mr. Moore's statements to the third person. Where the first person is used, the present editor must be held responsible.—T. H.

² 'On the Nature of Atheroma in the Arteries,' *Guy's Hospital Reports. Pathological Anatomy*, by Wilks and Moxon.

degeneration of the inflamed tissue, leading to softening of the thickened wall of the vessel, or else to a semi-cartilaginous hardening of the middle coat.

On the stage of fatty degeneration other more considerable changes follow. In some cases (and chiefly, as Wilks and Moxon believe, in the young) the whole calibre of the vessel is softened over a considerable extent—‘inflammatory mollities,’ as they term it; and then the softened wall will probably yield to the force of the circulation, and an aneurismal pouch will be formed. In other instances only a very small patch of artery softens, and this softened part is washed away by the blood stream, leading to what has been termed ‘the atheromatous ulcer.’ Usually this ulceration does not perforate the vessel—at least in the early stage of the disease; but I have known a previously healthy man in the prime of life to die suddenly of hæmorrhage from a single minute ulcer of this nature in the thoracic aorta; or, here again, the coat of the vessel may yield more gradually, and a pedunculated aneurism may be formed. More commonly, however, the thickened atheromatous wall of the artery becomes gradually invaded by earthy matter, leading to the cretification (so-called ‘ossification’) of the artery—a change which ensues also on the semi-cartilaginous hardening of the vessel.

So extensive is this cretification, that very often all the superficial arteries can be felt as rigid trunks under the skin; and on laying them open in the dead body they crack rather than are cut by the scissors; and their lining membrane is found rough and studded with hard plates of bony consistence. But, on the other hand, the degeneration may attack only a very limited portion of the vascular system, and in that case is generally confined to the aorta, though there are not wanting instances in which the great trunk escapes, while the smaller vessels are invaded.

The aorta may be diseased throughout, yet the coronary arteries may be healthy; and it is interesting to contrast the highly nourished state of the heart in such a case with its condition when its nutrient arteries are diseased. The aortic valves, the commencement or the whole of the arch, may be atheromatous, and no other vessel be affected. Isolated patches of the disease may occur between long tracts of healthy artery, and it is of the greatest importance in surgery to know this fact in relation to the popliteal and axillary arteries, of which short portions may be even ossified, while the femoral and subclavian, so far as concerns the possibility of their being successfully tied, are healthy. When at all advanced, the disease is found to be symmetrical, the arteries of opposite limbs being equally and similarly affected. This fact is well illustrated in the not unfrequent occurrence of parallel, almost contemporaneous, popliteal aneurisms in the same person. Some vessels are earlier, if not more frequently, affected with the disease than others. There is such a preponderance in the lower extremity over the upper, both in the proneness of its vessels to the disease, and in the degree which atheroma attains in the more distant limb. Some entire arteries rarely become atheromatous. Those of the stomach, liver, and intestines are remarkably exempt from this affection, even though it may have attained an advanced degree in the splenic and the other arteries of the body. As a general rule, atheroma is a disease of the arterial trunks and larger branches, but it is occasionally met with in very small vessels. Haller once met with atheroma in the hypogastric artery, but it is the only case on record. The most marked exemption, however, is that of the venous system, including the pulmonary artery and its branches; and it is a very suggestive fact in reference to the causation of the whole disease. Atheroma, even its early stage, is rarely found in the vessels which carry venous blood; and when it does occur, it is associated with extensive disease in the aortic system; or with hypertrophy of the heart from chronic bronchitis or mitral disease. Atheroma is a disease which is found especially in advanced life, though it is by no means confined to advanced life, nor even to the human subject.¹ Various

¹ Young found calcareous concretions in the arteries of an infant; Wilson in a young child; and Andral in the aorta of a child of eight years of age. The latter author also met with ossific laminæ in the aorta in five or six persons of from eighteen to twenty-four years of age, and an extensive ossification of the superior mesenteric artery of a person not quite thirty (Copland, *Diet. Med.* vol. i. p. 119). Corfe (*Physiognomy of Diseases*, p. 129) records an instance of fatal aneurism, as arising from this disease, at the age of twenty-eight; and in the Hunterian Museum, No. 1679, is a specimen of it in a jaguar.

causes have been assigned as originating the chronic arteritis of which atheroma is the result. It appears to me undeniable that strain on the arterial wall is the cause which is most clearly proved to be present in most cases of atheroma, and which most fully accounts for the constant occurrence of atheroma in the largest arteries, and in those parts of them which are most exposed to increased pressure, for its greatly increased prevalence in the male sex, and in those occupations which involve most strain on the heart and great vessels, for its rare coexistence with those general affections (as phthisis and mitral obstruction) which diminish arterial pressure, and for its appearance in the pulmonary vessels when the hypertrophy of the right side of the heart increases the strain upon them.¹ This view of the causation of the disease does not, I think, exclude the abuse of alcohol; and there are strong grounds for believing that alcoholic excess favours the production of atheroma. As Mr. Moore, in the last edition of this work, says: 'There can be no question of its frequent, if not invariable, occurrence in drunkards.' Alcohol drinking may act in either or both of two ways—viz. either by producing conditions of varying excess and feebleness of circulation, *i.e.* varying and sometimes excessive tension, or by interfering with the nutrition of the vascular tissue and diminishing its powers of resistance. Syphilis is believed by many surgeons, and especially those of the army,² to produce gummatous deposits in the internal or middle coat of the arteries—'aortic nodes,' as they are called—which soften and thus lead to atheroma. But the difficulty in accepting this theory as proved (though few would question its probability) is that most of these syphilitic soldiers have been exposed to the previously named causes of atheroma, while prostitutes, who lead easier and quieter lives, seem to escape. Acute rheumatism may, I think, be reckoned among the undoubted causes of arterial degeneration.

The atheromatous change in an artery is slow in its progress, and can only when far advanced be detected in the living subject. It is occasionally attended with persistent pain, which is liable to be mistaken for a rheumatic pain. When actually ossified, an artery which can be felt at all may be readily distinguished as thus diseased. In the radial, for instance, rings of chalky matter can be recognised as the finger is moved along the vessel. But attention is often first called to the state of the arteries rather by some secondary symptom of their disease than by the atheroma itself.

The microscopic examination of the thickened patches in the wall of an artery, which precede the occurrence of softening, show a distinctly inflammatory change, viz. nuclei (or 'leucocytes') passing into fibre-cells, and thence to formed fibrous tissue. When the softening stage, to which the term 'atheroma' is most appropriate, has been developed, cholesterine plates, granular débris, and caseous particles, with a few phosphatic crystals, are found.³

1. *Effects of atheroma. Narrowing or plugging of the vessel.*—Atheroma is at first attended with a narrowing of the calibre of the vessel, in proportion to the thickness in which it is deposited. This is most marked at the bifurcation of trunks, and at the mouths of small vessels passing off from large trunks. In no spot is it more commonly observed than at the origins of the intercostal and similar arteries, which branch off at right angles from the aorta, and which are sometimes not only narrowed, but at last completely closed, by the accumulated deposit. Though the larger arteries are perhaps never obliterated by this process, yet even they may be much contracted by it. The canal of so large a vessel as the common iliac has been found diminished by one-half,⁴ and the great ascending branches of the arch of the aorta nearly obliterated.

¹ Wilks and Moxon, *Pathl. Anatomy*, 2nd ed. p. 150.

² See the very interesting paper by Mr. Welch on 'Aortic Aneurism in the Army,' *Med.-Chir. Trans.* lix. 59.

³ *Med.-Chir. Trans.* vol. lix. pl. iv. appended to Mr. Welch's paper. See also Gulliver, *Med.-Chir. Trans.* vol. xxvi. p. 90.

⁴ Hunterian Museum, No. 1614.

A diminution of the size of branch-vessels from this cause may prove to be of serious importance in some cases, by hindering the establishment of a collateral circulation.

2. A later consequence of the disease is *dilatation of the vessel*. The outer coats being incapable of compressing the deposit, and closing in upon the blood after each cardiac systole, they fail to contract during the diastole, and the artery gradually expands. This enlargement is the most marked in those parts of the vessels through which the current of the blood is in any degree obstructed. All the curved arteries, therefore, are disproportionately dilated. It is observed also in all parts at which an arterial trunk naturally widens in its course, and suffers in consequence a more forcible internal hydraulic pressure than the smaller tube which leads to it. The upper extremity of the common carotid is thus widened naturally, and dilated when atheromatous. In that situation, at the upper end of the innominate, and in the higher part of the femoral artery, this expansion of the vessel may be mistaken for aneurism.

3. *Tortuosity of the vessel*.—The same mechanism which converts an artery into a fixed tube, incapable of contraction, but liable to dilatation, produces a similar effect upon its power of retraction. A healthy artery is in a state of longitudinal tension. It is, as it were, too short for the limb to which it belongs; and if cut across, may shorten an inch or more. Atheromatous and bony plates destroy this retractile power. But, though incapable of shortening itself, the vessel may be lengthened by the repeated injections of blood along it. Arteries, therefore, in which atheroma has reached an advanced degree, become not only dilated, but also tortuous. The outline of brachial arteries thus affected may be seen in the bare arm, every pulsation of the heart increasing their curvatures. The common and external iliac arteries, too, bend far from their normal position, the former arching outward and forward between the aorta and external iliac, the latter leaving its place upon the psoas, and curving deeply into the pelvis in a new course.

4. *Roughening of the lining membrane*.—An ossified artery does not retain that smoothness of its interior which characterised the earlier deposition within it. In a large vessel like the aorta, a bony plate may crack across, or be lifted at its edge from the wall of the vessel; and the sharp rough projection thus exposed may cause the adhesion of fibrine. Strings and masses of this substance, as it accumulates, materially lessen the calibre of the vessel, or, being broken off, and carried along with the stream of blood, plug any smaller artery in which they happen to be arrested. The ossification of smaller trunks, as the femoral arteries, produces in another manner a roughness of their canal. The bony matter being thickest, or sometimes only existing in circular rings, the vessel is strongest at those parts, while it yields between them. The interior of such a vessel is consequently no longer smooth, but is formed of a succession of alternate transverse ridges and bays; the former answering to the rings of bone, and the latter to the expanded spaces between them. Such an artery resembles the interior of a piece of jejunum, into the canal of which folds of the valvula conniventes project; and the effect of the arrangement, just as in the bowel, must be to retard the current.

5. *Partial rupture (so-called ulceration) of the vessel*.—It has been already mentioned that an atheromatous artery becomes dilated, and that it may yield and become aneurismal at a part from which the softened deposit on its interior has been washed away. It may be added, that the so-called ulcers of arteries, which are occasioned by the partial detachment or the cracking of calcareous deposits, 'are sometimes so deep as to reach, and even to perforate, the external or cellular tunic.'¹ Many cases are on record in which arteries thus diseased have given way spontaneously.

It is obvious that such rupture is the more liable to occur, as the disease is limited in extent. The artery yields at its one weak point.

¹ Hope, *Cycl. of Pract. Med.* vol. i. p. 145.

6. *Liability to injury in surgical operations or accidents.*—In relation to accidents, and surgical operations on arteries, atheroma assumes a serious importance. No longer tense, mobile, elastic, these vessels become rigid, brittle, and fixed. A direct blow may crack or crush them; a severe wrench, or sudden unusual movement of a limb, may half break them; the violence which dislocates a bone may tear them in two, and give rise to a vast escape of blood. Mr. Syme alleges that he has known an axillary aneurism follow such accidents as the repeated sudden shock of a machine against the elbow, and a quick unguarded movement in lifting the arm to the head for the purpose of holding on the hat in a breeze.

When a ligature is tied upon an ossified artery, the sensation conveyed by crushing the bony tube betrays its condition. Sometimes the artery gives way, and much difficulty is often experienced in securing it. This difficulty has suggested the plan of dissecting along the artery, and placing the ligature on it higher up. As it is uncertain, however, whether such an artery would be better adapted to bear a ligature in any higher part of its course, the safer plan seems to be that of securing it in the face of the stump. Such an artery could not be safely twisted, nor does it seem well adapted for acupressure. The best plan on the whole seems to be to tie it along with a considerable mass of the tissues surrounding it in a stout piece of carbolised catgut; but with any method secondary hæmorrhage is probable.

To atheroma and ossification are doubtless due the majority of the failures of operations for aneurism. Notoriously is this the case with the old operation, in which the artery was tied near the mouth of the aneurismal sac. And many times also, when the Hunterian operation has been adopted, the result has been disastrous from the same cause. The process of repair cannot be perfected in a tied artery, when the lining membrane is tough, or osseous, or in a state of fatty degeneration, when the middle coat is wasted, and the outer callous and attenuated, and when the rigid tube is incapable of contracting between the ligature and the next branch. From such an artery the ligature separates, perhaps earlier than from a healthy one, and hæmorrhage pours freely and fatally from one or both of its unclosed extremities. A prudent surgeon forbears from operating in such a case, or from tightening the ligature if he unexpectedly encounter a diseased vessel.

7. *Gangrene* may occur at different stages, and from various circumstances, in the course of atheroma; but, in itself, that disease is not capable of producing gangrene. For, so long as the vessels remain open, even though rigid, they allow blood to pass. And, in fact, any obstruction which may be occasioned by the roughness, is, to some extent, compensated for by the dilatation of their canal, and the distal parts obtain their nourishment. But should any unusual and considerable demand upon the circulation be made by a local injury or inflammation, the circulation will prove insufficient; and, as trees with tangled roots sometimes perish in a night upon a sudden increase in the rapidity of the flowing of the sap, the distal parts will die. Gangrene is often extensive when an ossified arterial trunk becomes occluded; and the explanation of the fact appears obvious. The collateral channels, through which alone the blood can reach the remoter parts, are themselves indurated or ossified, and are incapable of adapting their calibre to the larger stream which passes through them. The unnourished structures necessarily die. These occlusions of arterial trunks are not such as are very slowly completed by the accumulation of new matter at their orifices or bifurcations, but such as arise from the more rapid deposition of large masses of fibrine upon a rough part of an artery, or from the loosening and inversion of an osseous plate, or the washing of a detached cardiac vegetation down the current. The first, occurring comparatively early in the disease, can be made up for by the establishment of a collateral circulation; the others happen suddenly, in which case even healthy collateral arteries sometimes fail to preserve the life of a limb.

OCCLUSION OF ARTERIES.—EMBOLISM OR THROMBOSIS.

Some other causes of obstruction to the current of blood remain to be noticed, besides those by atheroma.

There are persons who, by certain postures of their limbs, are able to stop the pulsation of their arteries. The radials and tibials cease to beat upon forcible flexion of the elbows and knees. Others can so depress the clavicle upon the subclavian artery, or raise that vessel by a forcible expiratory compression of the lungs, as to arrest circulation in the arm. Arteries displaced by fragments of bone are often without pulsation until the fracture is set. An exuberant osseous deposition around the fragments of a fractured bone may, it is alleged, compress adjoining blood-vessels. The situation in which this has been observed to happen is the fibrous canal in the adductor muscles of the thigh. This, however, must be very rare, and as a general rule such obstruction of an artery only occurs when the artery itself is injured, or the fracture has not been replaced.

In like manner, that is to say by outward compression, morbid growths in the vicinity of blood-vessels enfeeble or stop the circulation. An exostosis once grew on the first rib in such a relation to the subclavian artery as to give rise to the symptoms of an aneurism of that vessel, and lead the surgeon who had charge of the case to tie the artery. Cancerous, and more rarely the innocent, tumours, compress and obliterate arterial trunks, which are found flattened, and either pervious or occluded with coagula or adherent fibrine. Even gangrene may follow the occlusion of an artery from this cause. This, however, is a rare event, as time elapses before the compression becomes complete, and blood, in some small quantity, continues to be driven through the flattened vessel. It is far from uncommon for the carotid or subclavian artery to be so compressed by the pressure of an aortic or innominate aneurism that no pulse can be detected in its branches, though after death the artery itself is found to be perfectly unobstructed. The obliteration of aneurismal vessels will be found explained at large in the essay on ANEURISM.

One other cause of the occlusion of an artery remains for consideration—that, namely, in which its canal is closed by an impacted foreign body. To these cases the name of embolism is now usually given, the kindred term thrombosis being reserved for the obliteration of veins. Some authors, however, speak indifferently of thrombosis of arteries or embolism of veins—in which use of the terms a vessel would be said to be embolic when the clot is presumed to have been carried down and impacted from a higher part of the circulation; thrombosed when the obstructing clot is believed to be formed *in situ*. Of the former event innumerable cases have now been observed. An artery is found plugged by fragments of morbid growths, which have been detached from one part of the circulating system, and transported into some other part along the stream of blood. The plug which is found occluding the distal vessel has often no organic connection with its walls, and is detained in its place merely by having reached an artery too small to give it further passage. The accident is usually met with in the aortic system, and the most common situation from which such fragments are detached is the left side of the heart. Many morbid vegetations adhere to the mitral and aortic valves loosely or by pedicles, and may be broken off by the rush of blood into or out of the ventricle. Some, but smaller, fragments may, as Mr. Lee suggests, be washed out of the atheromatous parts of the larger vessels.¹

So long ago as 1837, it occurred to M. Legroux² to explain a case of sudden obstruction of the arteries of the lower extremities by the passage of the fibrinous plugs found in them from the heart. A similar explanation was given by M. Laugier to the Anatomical Society of Paris, in 1849, respecting a yet more remarkable case. A healthy young man died with a needle in the left ventricle of his heart, and with gangrene of the left leg. The needle was found fixed in the apex of the ventricle, with its point directed towards the aortic

¹ Lee, on 'Gangraena Senilis,' *British and Foreign Medico-Chirurg. Review*, vol. xx. p. 214.

² *Bulletin de l'Acad. royale de Médecine*, tome i. p. 434.

orifice, and covered with 'decolorised sanguineous concretions, very coherent and irregular,' which were prolonged into the aorta. The lower end of the aorta, and the iliac arteries on both sides, were filled with an adherent clot. It seemed plain that the plugging of the latter, and the consequent gangrene, had their origin in the detachment of fragments of the lymph which had first adhered to the needle.¹ Since that time the researches of Dr. Kirkes have shown a similar occurrence to take place in the cerebral arteries. Sir J. Paget has demonstrated it in the pulmonary arteries; and Virchow, Simpson, and others have made us acquainted with it in other vessels.

An accident precisely similar in its nature, but occurring in another portion of the circulating system, is now known to be occasionally fatal in acute rheumatism, as well as to bring on the most fearfully sudden deaths in some puerperal women. The plugged artery in these cases is the pulmonary, or several of its branches, and the plug is either formed in the right side of the heart, or passes through it from the systemic veins.²

The facts from which the explanation of these occlusions of arteries is chiefly drawn have already been partly stated: 1. The artery is often healthy at the site of the obstruction. It may, indeed, be atheromatous, inasmuch as the occurrence in question prevails most in persons whose arterial system is diseased. Yet it is often healthy, as might be expected if the disease originated elsewhere. Sometimes the vessel is dilated to nearly twice its natural size, and, in the branches of the internal carotid especially, this enlargement renders the situation of the plug evident before the artery is opened. 2. The plug is frequently not adherent to the vessel. The cases under consideration were for a long time regarded as effusions of lymph from the surface of an inflamed artery; but when the artery is healthy, and the plug free, that explanation is plainly erroneous. There are, indeed, not a few instances in which the coats of the artery are inflamed, and even suppuration has taken place in the surrounding structures; in these circumstances the plug is found adherent. The inflammation, however, and the adhesion are alike the result of the previous presence of the plug. 3. The impacted plug can be distinguished from the inflammatory lymph and coagulum which are formed in its immediate neighbourhood. Drs. Burrows and Rühle have given the most undeniable evidence of this fact, and have all but demonstrably traced the plug to another place of origin. Each of these observers detected a calcareous plug occluding an artery, and similar calcareous matter still attached to the wall of the heart.³ 4. The cessation of the circulation in the occluded artery is too abrupt to have arisen from a gradual accumulation of fibrine. It has probably not always been discovered to be instantaneous, because the pulse has not been under examination at the moment of the occlusion. 5. The severe pain which first calls attention to the accident, and death, as it happens from such obstructions of the pulmonary artery, are both sometimes sudden. 6. After loss of sight from this cause, the twigs of the retinal artery are seen with the ophthalmoscope to be bloodless upon the distal side of the plug. It seems probable enough, however, that the obstruction is often incomplete at first, and that the impacted clot attracts fibrine to itself until the tube of the vessel is completely filled.

Besides these cases of genuine embolism, in which a plug is carried down into the vessel from a higher part of the circulation, there can be no question that cases occur which would more appropriately be called 'arterial thrombosis,' in which the vessel is gradually filled with clot formed at the part obstructed. This has been already spoken of as occurring in arteritis; it occurs also in fevers, especially typhus,⁴ obviously from some affection of the blood; and it is the opinion of some eminent pathologists⁵ that coagulation may occur even in large arteries from causes at present

¹ Cruveilhier, *Traité d'Anatomie pathologique générale*, tome ii. pp. 201, 296, 388.

² *Obstetric Memoirs*, by Sir James Y. Simpson and his editors, Drs. Priestley and Storer, vol. ii.

³ *Medical Times*, 1853, p. 135; *Virchow's Archiv.* vol. v. p. 189.

⁴ See a typical case reported by Dr. Murchison in *Path. Trans.* xvi. 93. I would refer the reader to the article on GANGRENE, vol. i. p. 122.

⁵ See a report by Dr. Murchison and Dr. Bristowe, on a case of obstruction of the pulmonary artery and its branches, recorded by Dr. Payne in *Path. Trans.* xix. 149.

unexplained, but, as they believe, independent of inflammation or degeneration of the external walls, or any mechanical obstruction to the circulation.

It would far exceed the limits of this article to trace the results of obstruction of the arteries in the various parts and organs of the body in which it has been shown to occur. As there is no trunk which may not be occluded by a detached plug, the abdominal aorta itself not escaping, so there is no organ which may not have its function impaired, or its structure destroyed, by the deprivation of blood which this accident occasions. Organs with single arterial trunks, as the testicle, retina, or spleen, may lose their function when thus deprived of their whole supply of blood.

When the principal artery of a limb is suddenly plugged in its higher part, severe pain is commonly the immediate result of the accident. In some cases this pain extends along the course of the vessel, which, though pulseless, is extremely tender; in others the suffering is referred to some distal part of the limb, as, for instance, to the calf. Signs of a deficient circulation succeed; and they may amount to pallor, loss of temperature, numbness of the surface, or even to that 'torpor' which in certain injuries of vessels is observed to precede the total death of a limb. Such torpor implies not only a loss of circulating blood in the limb, but also a cessation of feeling and motor power, and it may issue in actual mortification.

It is not every case of obstructed artery which terminates in gangrene. A collateral circulation may be established, and the life of the limb be saved. Very young subjects bear such an accident without any ensuing mortification. An infant will endure without loss of life the gradual obliteration of even the aorta itself at the termination of its arch. Mr. Savory has recorded an instance, probably congenital, in which 'all the main arteries of both upper extremities and of the left side of the neck were reduced to solid cords;' yet no gangrene occurred.¹

The subjects of gangrene from an impacted clot have a general feebleness of the system, which may account for the progress and great mortality of it. Some persons die before any line of demarcation is formed; more sink during the process of separating the dead portion of the limb; a few survive until all its tissues are naturally severed, except the bones and some tendons. Upon the division of these, the stump may heal.

Some at least of the obscurity which invests the subject of *senile gangrene* is cleared away, if obliteration of some of the arteries be recognised among its causes. There are commonly preliminary symptoms which may have indicated arterial disease: chilliness of the foot or hand, and frequent pains for many months, forbode the attack, and the gangrene at length originates and advances by a local dusky inflammation. In these particulars the gangrene of the aged is unlike that which is suddenly produced in younger subjects by obstructed arteries, but sometimes an arterial cause of senile gangrene can be traced.

Treatment.—The occlusions of arterial trunks which are caused by external compression can rarely be relieved. For innocent tumours seldom interfere with the circulation, being rather themselves grooved by an artery than compressing it; and malignant growths, when they have reached a size and a position in which they can produce such an effect, are commonly unsuitable for an operation. No special suggestion is required for the treatment of arteries implicated with broken bones, and none can be offered for their compression in certain situations by the growth of new bone about the fragments. The chief attention will necessarily be claimed by the manifest cause of the obstruction, at the same time that all efforts must be directed to preserving the life of the limb by warmth and a suitable posture.

In the treatment of arteries suddenly occluded, it may be possible at an early stage by reasonable pressure to break up a soft recent plug in a superficial vessel, that its fragments may pass into arteries of less importance to the limb. If this be not possible or proper, care must be directed to preserve the temperature of the limb,

¹ *Medico-Chirurgical Transactions*, vol. xxxix. p. 214.

to favour the establishment of a collateral circulation, to maintain the efficiency of the blood by suitable nourishment, to relieve pain by methods which will least interfere with the appetite, and, more than all, to guard the weakened limb from irritation and injury, which might overtask the little vital power it still retains: these are the indications before the occurrence of gangrene. When that event has commenced, the course advised in the essay on that subject must be adopted.

A new growth, described by Dr. Moxon under the name of Periangioma, is a rare instance of disease limited to the outer coat and sheath of arteries. It formed a tumour of the scalp, permeated by enlarged and tortuous vessels, and made up of new material occupying uniformly their outermost and circumvascular structures.¹

C. H. MOORE, 1870.

T. HOLMES, 1882.

¹ 'Periangioma of Scalp; excision; recovery.' By Mr. Thomas Bryant. *Trans. of Path. Soc.* vol. xix. p. 376.

ANEURISM.

PATHOLOGY.

AN aneurism is defined to be a tumour containing blood, and communicating with the cavity of an artery. Thus in every aneurism there are two parts to be considered, the sac¹ and its contents. The sac is formed either by the vessel itself dilated from disease, or by the condensed soft parts in the neighbourhood.

The various classifications of aneurism now in common use are based upon varieties in the anatomy of the sac. The most natural nomenclature appears to me to be that which would term an aneurism formed by the coats (one or more) of the artery a true aneurism, and one formed by the surrounding cellular tissue a false aneurism. Unfortunately the term 'true aneurism' was applied by the older authors to a tumour in which all the coats of the vessel were dilated, while they called one in which only one of the coats formed the sac 'a false aneurism;' a very inappropriate name, inasmuch as such aneurisms form the majority of those met with in practice, while the term 'false' appears to convey the idea of something exceptional and peculiar. It is undesirable to complicate the matter still further by the attempt to introduce fresh terms. I shall therefore adhere to the old nomenclature, in spite of my opinion of its incorrectness; merely observing that these anatomical refinements are of very little importance in practice: that no one troubles himself as to how many coats of the artery enter into the formation of a sac, or has any means of forming an opinion on the point before dissection. But it is very important to ascertain whether the blood is contained in a sac or no, whether that sac is or is not perfect, and whether the aneurism is of spontaneous or traumatic origin.

The term 'diffused aneurism' is also, I must confess, an inappropriate one as used to describe a tumour in which the sac is formed out of the cellular tissue; since such a tumour is as distinct and circumscribed as if the sac were formed by the vessel itself; and accordingly in many works an aneurism is said to be diffused when the sac has given way. Such an affection, however, is equally well or better described as 'a ruptured aneurism.' The term 'diffused' serves indeed to remind us that the blood, though now encysted, was once diffused among the neighbouring parts: but as it is liable to be confounded with the same term as used by other authors to designate extravasations from rupture, I shall prefer to use in the sequel the name 'consecutive aneurism' for such aneurisms as have the sac formed out of the tissues external to the vessel. In order as far as possible to avoid ambiguities, the nomenclature adopted in this essay is contrasted with that hitherto common in France and England: M. Broca's treatise being used as an example of the former, and the chapter on Aneurism in Mr. Erichsen's 'Science and Art of Surgery' for the latter.

The kinds of aneurism to be described below are as follows:

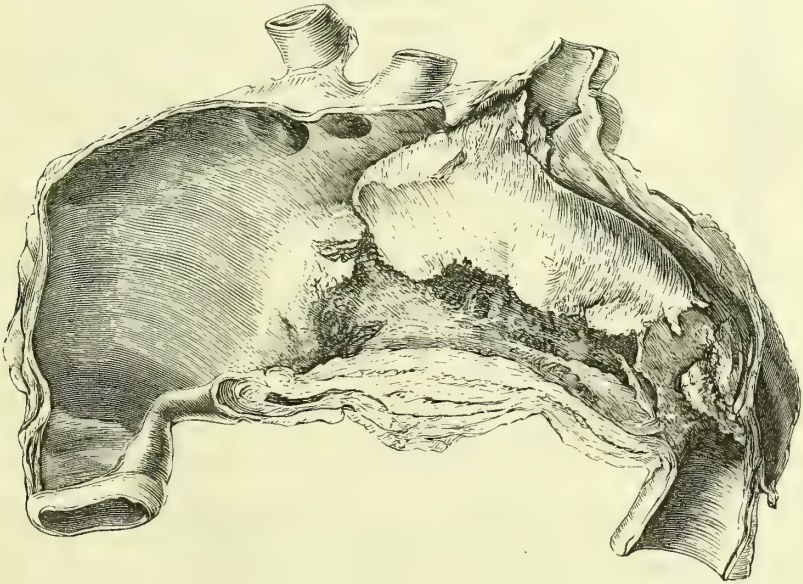
¹ Some authors speak of extravasations of blood among the tissues of a limb, from the giving way of an artery, as 'diffused aneurisms:' but this appears to me an error. I should term this lesion 'a ruptured artery.' The distinction, as I hope to show, is not a trivial one.

1. Common or encysted aneurism (circumscribed an. Br.), subdivided into
 - (a) Fusiform aneurism, or aneurismal dilatation (fusiform or tubular an. Er. Excluded from Br.'s classification).
 - (b) True aneurism (same in Br., true sacculated an. Er.)
 - (c) False aneurism (mixed external an. Br., circumscribed false sacculated an. Er.)
 - (d) Consecutive or diffused aneurism (false or encysted an. Br., diffused false sacculated an. Er.)¹
2. Arterio-venous aneurism, subdivided into varicose aneurism and aneurismal varix (simple phlebartery, Br.)
3. Cirroid aneurism, sometimes called arterial varix. Aneurism by anastomosis will also be considered under this head.
4. Dissecting aneurism.

COMMON OR ENCYSTED ANEURISM.

By common or encysted aneurism is meant that variety of the disease, embracing by far the greater number of cases, in which the tumour is formed of a single cyst, communicates only with a single artery, and is limited to a single point of the

FIG. 1.—Fusiform Aneurism, or Aneurismal Dilatation, of the Aorta, half filled with laminated coagulum. (From the Museum of the Royal College of Surgeons, No. 1641.) To show the possibility of the deposit of clot of such aneurisms, and even of spontaneous cure, with preservation of the channel of the vessel.



course of that artery. Some of the subdivisions of this affection are practically very different from each other, while between others the difference is unimportant, and in fact usually inappreciable during life.

In the *aneurismal dilatation*, or *fusiform aneurism*, the whole circumference of the artery has yielded to the force of the circulation for some considerable length of the vessel, and so a tumour has been developed, of an elongated or somewhat cylindrical shape, continuous with the cavity of the artery at each end. The coats of the vessel are generally much thinned and highly atheromatous. This form of aneurism seldom contains much clot. It is of more common occurrence in the aorta, but rare in the arteries of the limbs; the most usual situations below the aorta being the innominate, the top of the common carotid, and the inguinal portion of the external iliac and femoral. Some authors separate the aneurismal dilatation entirely

¹ Under this head Erichsen and some other authors also include extravasations without a sac—*i.e.* subcutaneous rupture of an artery.

from the category of aneurisms, and treat of it as a distinct disease; but no pathological distinction can be made between this and other forms of dilated artery which would not be subject to endless exceptions and modifications, and in practice this affection is often indistinguishable from the 'true' aneurism.

True aneurism is defined to be a circumscribed dilatation of an artery in a part only of its circumference, in which all three coats of the vessel are dilated to form the sac, while in a (so-called) *false* aneurism the two internal coats have given way and disappeared, and the sac is formed only by the external, or cellular, coat.

FIG. 2. — A small Aneurism of the Radial Artery. (Museum of the Royal College of Surgeons, No. 1697.) To show the usual shape and relations of a common or encysted aneurism, which stands out like a bud from a portion of the circumference of the vessel.



The true aneurism, like the aneurismal dilatation, of which it may be regarded as a variety, is much more common in the aorta than in any other vessel, and small aneurisms of this nature may be occasionally demonstrated by dissection in this and other large arteries; but in the larger aneurisms it is impossible to trace the internal coats for any considerable distance from the mouth of the sac, so that there is no difference between true and false aneurisms at the time at which they generally come under observation; and it is not worth while to say more on the subject, beyond stating that the true become false as they grow; and expressing an opinion, founded on the manner of their origin, that false aneurisms are far the most common.

Another form of false aneurism is described by authors of credit, and must therefore be noticed here, although its reality is doubtful. It is sometimes called 'hernial' aneurism, and the sac is formed by a projection, or hernia, of the two inner coats, or some portion of them, through a rent or an ulcerated opening in the external tunic. Whether the cases which have been put on record really prove the existence of this affection, must be left to the reader to decide for himself. It is a point rather of curiosity than of practical interest.¹

The other form of encysted aneurism is the *consecutive* or *diffused*, in which all the coats of the artery (or, as frequently happens, the sac of a previous aneurism) have given way, and the blood is effused into the cellular tissue. The latter soon becomes condensed, and forms, with the muscles, ligaments, viscera, or bones in the neighbourhood, a sac for the blood, frequently distinguished from those of the previous varieties by being multilocular. The great majority of aneurisms are, if the terms be strictly construed, of the consecutive form; since few tumours of long standing will be found in which some part, at any rate, of the sac has not been borrowed from surrounding tissues.²

Such are the varieties of common aneurism, classified according to the anatomy of the sac. Other principles of classification have been proposed. Thus, some surgeons prefer dividing aneurisms, according to their form, into tubular, sacculated, and dissecting;³ and frequently aneurisms are named, according to their cause,

¹ There is a preparation in the Museum of the College of Surgeons intended to show this form of aneurism. Mr. Erichsen, however, reports, as the result of his examination of this specimen, that he believes the external coat not to have been originally deficient, but to have been dissected off (Cooper's *Surgical Dictionary*, 8th ed. 1861, p. 140). In this opinion I quite concur. The line at which the external coat had been cut away is distinctly marked all round the neck of the sac. M. Broca expresses his disbelief in the reality of hernial aneurism.

² I would wish, at the risk of being accused of repetition, again to remind the reader that the term 'diffused aneurism' is very often applied to a *ruptured* aneurism, and even to a ruptured artery, i.e. to cases in which the blood is poured out into the cellular tissue, and infiltrates a great part of the limb without the formation of any sac. But I think that I shall be able to show reasons for saying that it is more correct, and is of considerable practical importance, to separate these cases altogether from cases of aneurism properly so called, and to limit that term to tumours provided with a sac.

³ Luke, in *Lond. Med. Gaz.* May 9, 1845; Erichsen, in Cooper's *Surg. Dict.* 8th ed.

traumatic or spontaneous. Each method of classification is occasionally useful; but the anatomical arrangement is most generally adopted.

Causes of aneurism.—In general terms it may be said that anything may be a cause of aneurism which destroys the balance that ought to exist between the expansive force of the circulation and the reaction of the wall of the artery, so as to make the former preponderate. But none of the ordinary events which are looked upon as exciting causes of the disease can produce it without a predisposing cause in the condition of the artery itself. This condition is, in the great majority of cases, the result of *atheroma*; but on that state of the arteries enough has already been said, and the reader is referred to the previous essay. Any other cause which produces a partial atrophy of the artery renders it liable to dilatation at the atrophied part: Vidal¹ remarks that the accidental exposure of an artery which ought to be deep-seated may induce aneurism, both by weakening the coats of the vessel, and by depriving it of the support of the soft parts. Unnatural and long-continued pressure may produce the same effect. Thus, a case is recorded in which the pressure of an exostosis produced aneurism.² The frequent occurrence of aneurisms in both popliteal arteries strikingly proves the origin of the affection in disease of the arterial system; the same thing is even more strongly shown by a case which is recorded of the formation of a popliteal aneurism in one ham, while the man was in bed for the treatment of an aneurism in the opposite ham. In extensive disease of the arteries, a great number of aneurisms may form, constituting what is called the ‘aneurismal diathesis.’³

It often happens, however, that aneurisms are found in arteries which appear healthy in all other parts of their course; and this seems to be more frequently the case, the farther the disease is from the heart. In these cases the nature of the predisposing cause is unknown. It has been alleged that mercury and syphilis predispose to aneurism; but the former assertion appears gratuitous, and the latter is doubtful. The abuse of ardent spirits is certainly an exciting cause, and may possibly produce some weakness of the vessels, so as to entitle us to consider it also as a predisposing cause. It is worthy of notice that the disease is almost unknown in early life;⁴ that external aneurisms (*i.e.* aneurisms of the limbs) are very rare among women, especially in the higher ranks of life;⁵ and that such aneurisms are found most commonly upon those arteries which are most affected by the movements of the joints; while aneurisms generally are most common at those points where the flexure, or the division of a large artery, opposes some sort of check to the blood-stream. The aorta, popliteal, and axillary artery seem most liable to disease, as being the most constantly subject to stretching, and the two latter to forcible rupture. The constant impulse of the blood-stream against the arch must keep the root of the aorta in more active motion than any other part of the arterial system.

The influence of forcible motion on the popliteal artery is shown by an experiment of Richerand.⁶ On a dead subject let the bones of the extended leg be forcibly driven down into the ham till the ligaments are heard to crack. The middle and internal coats of the popliteal artery will be found torn. It is true that the accidents commonly cited as causes

¹ *Traité de Pathol. externe*, 1851, vol. i. p. 645. The instance which he gives is one of exposure of the femoral artery in hospital gangrene.

² Roux, *Quarante Années*, &c. vol. ii. p. 131.

³ Broca (*Des Anévrismes et de leur Traitement*, p. 52) instances, among other cases of multiple aneurisms, one under the care of Pelletan, in which sixty-three were found in the same body.

⁴ A few cases are, however, on record. See Hutchinson, *Path. Soc. Trans.* v. 104; Syme, *Lond. and Edinb. Monthly Journ.* 1844; T. Smith, *Brit. Med. Journ.* March 10, 1867.

⁵ Internal aneurisms seem equally, if not more, common among women, when their way of life exposes them to the vascular excitement consequent on intemperance, vice, and mental emotions. Thus Dr. Rendle informs me that aneurism is a more common cause of death amongst female than male prisoners.

⁶ *Nosog. Chir.* vol. iv. 73. Hodgson, *On Diseases of the Arteries and Veins*, ed. 1815, p. 64. In repeating this experiment, I have found that this is only occasionally true. I have sometimes found the artery entire; and on one occasion the external coat was somewhat lacerated, while the others remained entire.

of aneurism are not so severe as this rough proceeding; but slighter injury to the artery probably occurs, and lays the foundation for subsequent dilatation.

Again, the heart is often hypertrophied, as the consequence either of disease or of the habits of life of the patient; and where the artery is weakened by any of the above causes, it can no longer resist the increased impulse. Hence aneurism is regarded, with at any rate much probability, as a mechanical effect of the wearing out of the artery by use; the circular muscular fibres which constitute the strongest part of the wall of the vessel being, according to this theory, stretched, and partially separated. The fact that aneurism affects the systemic arteries only—*i.e.* only those vessels which convey red blood—has led some authors to believe that the formation of these tumours may depend in some unknown manner upon the quality of the blood conveyed by the artery. With our present knowledge of vital chemistry, it would be absurd even to affect to give an opinion upon the possibility of this. It seems quite sufficient to state that the pulmonary system receives the force of the right ventricle only, which is seldom hypertrophied, and which, at its strongest, is perhaps incapable of generating the expansive force necessary to produce aneurism.

A case of aneurism of the pulmonary artery is on record in which the ductus arteriosus was pervious, and so red blood was admitted into the artery. But it is not impossible that the force of the left ventricle might have been reflected along the open duct.

A more unmistakable case of pure aneurism of the pulmonary artery is the following, for which I am indebted to Dr. Rendle:—

The patient, a young woman, appeared in perfect health, when she was suddenly seized with acute pain beneath the left scapula. In two hours there was emphysema of the side; this rapidly extended over the back, chest, neck, face, arms, and even as far as one wrist. About three weeks after she brought up blood, and died immediately. The left bronchus was pierced by a small triangular opening close below the bifurcation, from which the air had escaped. The cartilaginous rings were bared and ulcerated from pressure of an aneurism of the pulmonary artery. The aneurismal sac was very small: not larger than a horse-bean.

In some persons affected with the so-called 'aneurismal diathesis,' the whole arterial system shows an extraordinary tendency to aneurism, without, as is said, any visible anatomical peculiarity in the vessels; but in ordinary cases of this diathesis the vessels are evidently soft and weak.

When, by any of these predisposing conditions, the wall of the vessel is sufficiently weakened, it will give way at the weakened part to the force of the circulation, and all the more surely if that force is temporarily increased by any unusual circumstance, which thus becomes an exciting cause. Hence, perhaps, the frequent occurrence of aneurism in persons of dissipated lives, and in persons who follow laborious occupations; by which not only is the heart's action unduly increased from time to time, but also the arteries of the limbs are exposed to frequent shocks. Hence violent mental emotion sometimes gives rise to aneurism.

Occupations which necessitate constant exercise of a limb, and frequent strains upon its joints, act both as predisposing and exciting causes of aneurism in the arteries lying near such joints. Popliteal aneurism seems to be caused in very many instances by the giving way of the circular coat of the vessel under the alternate movements of forced extension and violent flexion, to which that artery is exposed in the movements of the knee. Suppuration near an artery may lead to the formation of a consecutive aneurism, the wall of the vessel being perforated by ulceration, and the blood admitted into the sac of the abscess. This seems to be a very rare event; but suppuration around an artery may also act as a predisposing cause, by denuding the vessel, as has been already pointed out. Unmistakable instances, however, of abscesses converted into aneurisms are on record.

Mr. Liston's case is well known,¹ in which he opened a cyst communicating with the internal carotid artery, believing it to be an abscess, and in which he was obliged, in consequence of the gush of blood that followed the puncture, to place a ligature on the common

¹ *On a Variety of False Aneurism*, London, 1842. An interesting case of fatal hæmorrhage from communication between an abscess in the neck and the aorta is recorded by Mr. Busk, *Med.-Chir. Trans.* vol. xxix. p. 297.

carotid. The patient died of secondary hæmorrhage, the result of the operation; and on post-mortem examination Mr. Liston found reason to believe that the disease was originally an abscess which had established a communication with the artery. Whatever may be thought of the real nature of the tumour in that case, there can be little doubt that several of the other cases which are related in Mr. Liston's paper were genuine instances of communication between abscesses and arteries. These abscesses may be the result of struma, cancer, or common inflammation. In the 34th volume of the 'Medico-Chirurgical Transactions' is a very interesting case by Mr. Dixon, in which a hydatid cyst, having been laid open, sloughed, and so established a communication with the subclavian artery. The patient died of hæmorrhage. This is the ordinary result in cases of ulceration penetrating arteries. No aneurism is formed, since there is an open wound. But, in the rarer cases, such as those referred to above, the suppuration proceeds subcutaneously, and a consecutive aneurism is formed. Possibly Mr. Liston's case may have been an example of this event; but the diagnosis must be allowed to be doubtful.

The impaction of a clot of fibrine in the artery may lead to its dilatation behind the obstruction, and thus to the formation of an aneurism.

FIG. 3. Aneurism formed by Embolism.

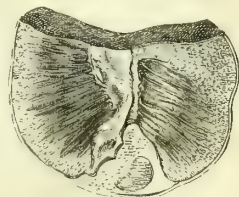
FIG. 4.



Fig. 3 shows an aneurism of the ulnar artery; *a*, *b*, the artery, its lower end closed by clot; *c*, the sac partly filled with coagulum; fig. 4 shows the deposit on the lining membrane of the heart.

Mr. Tufnell has put on record ¹ a remarkable case, in which a pulsating tumour formed in the ham, in a patient who was dying from rheumatic disease of the aortic valves. The tumour subsided with simultaneous enlargement of the collateral branches; and after death the artery was found plugged with fibrine and somewhat dilated. In this case it seems clear that the artery, being healthy at the part where the clot became impacted, yielded to the force of the (hypertrophied) heart to such an extent as to form a tolerably large pulsating tumour, but that, as the collateral circulation enlarged, it was enabled nearly to recover its healthy dimensions. Such a case is illustrated by the accompanying figures, showing an aneurism which formed on the ulnar artery of a lad, aged 17, who died under Mr. Pollock's care at St. George's Hospital in the year 1864. The deposit on the valves and the embolic clot in the kidney are also shown. The spleen was similarly affected. The artery in other parts was healthy.² If the same accident were to take place in an artery enfeebled by atheromatous degeneration, no doubt the aneurism would go on increasing.

FIG. 5.—A block of Fibrine deposited in the Kidney in the same case. (From a drawing in St. George's Hospital Museum. Series xxi. No. 60.)



The objection which has been urged against this mode of formation of aneurism, viz. that aneurisms do not form on arteries suddenly obstructed by ligature, is an unsound one, since they do so form,

¹ *Dublin Quarterly Journal*, May 1853.

² See also a case reported by the writer in the *Path. Soc. Trans.* vol. xii. p. 61.

although rarely.¹ In most of these cases of aneurism produced by embolism the artery is previously diseased.

Such are the causes, predisposing and exciting, of spontaneous aneurism. The term 'traumatic aneurism' is usually intended to include only those instances in which aneurism follows a wound known to have been inflicted upon an artery; and this wound is, of course, in the great majority of cases, an open one. In such a case, the wound in the skin usually unites under pressure; the issuing current of blood prevents the lips of the orifice in the vessel from coming together, while the reaction of the neighbouring parts, the pressure of muscles and fasciæ, and the supervention of syncope from loss of blood, prevent the unlimited infiltration of blood into the cellular tissue, and the death of the patient from that cause. The blood, being thus hemmed in, quickly loses its more fluid part by absorption, and becomes a more or less solid body, and is encysted in the same way as other foreign substances. In other cases no skin-wound exists; of which the most common instance is the wound of a vessel by a fractured bone, and here the process of formation of the aneurism is the same. The form of aneurism is, therefore, the consecutive; and, *vice versâ*, most consecutive aneurisms are traumatic. Many are, however, spontaneous, being caused either by ulceration perforating an artery, as alleged in Liston's case, or (which is very common) from the rupture of a previously existing aneurism. It has been above noticed that many, if not most, of the aneurisms which surgeons have to treat are, in one sense, traumatic, as having been probably caused by injury; the term is, however, usually restricted to those cases in which the vessel is known to have been penetrated, and will be so used in the sequel.

Progress of aneurism.—When once formed, the tumour is likely to go on increasing as long as the conditions subsist in which it originated. These conditions vary so much, according to the state of the sac, of the parts around it, and of the blood which it contains, that it is impossible to form a clear idea of the disease without studying each of these separately.

The changes in the sac depend in a great measure upon the position and size of its communication with the artery, and somewhat upon the direction in which the sac grows and the part of the artery in which the opening is seated: thus, sometimes the opening is situated on the concavity of the curve of a vessel, so that the artery is stretched over the tumour; more frequently on the convexity or bend of the artery; sometimes the arrangement of the neighbouring parts is such that the tumour can only grow in the opposite direction to the current of blood, or that pouches are formed in it. It would carry us beyond our limits to refer to instances of such arrangements, and to point out the variations in growth and progress to which they seem to have given rise. In a fusiform aneurism, in which the orifices of exit and entrance are free, the lateral pressure upon the sac cannot be severe. Hence these aneurisms advance slowly, and do not readily burst. On the other hand, pedunculated aneurisms, in which the sac communicates by a narrow channel with the arterial stream, are seldom found of large size, having usually burst before they attain anything like the size sometimes reached by the aneurismal dilatation.² The reason of this fact, no doubt, is, that the impact of the stream of blood through the narrow orifice (supposing that orifice unobstructed) is concentrated more upon one point, instead of being diffused over the whole wall of the sac, as in the previous variety. Between these two extremes there are, of course, all possible shades of difference; but in every aneurism, properly so called, as distinguished from a mere dilatation, the pressure on the wall of the sac is much greater than the natural pressure of the heart.

This may be illustrated by a reference to the scientific toy known as the hydrostatic paradox,³ in which a small pipe communicates with a closed bellows, the pipe and bellows

¹ See WOUNDS OF THE VESSELS, vol. i. 363.

² Rokitansky, *Path. Anat.*; Syd. Soc. vol. iv. p. 280.

³ Or hydrostatic bellows. The machine will be found described in most treatises on hydrostatics; e.g. that in the *Encyc. Brit.* 8th ed. vol. xii. p. 81.

being filled with fluid. The smaller the opening in the bellows, the greater is the pressure on its walls. An aneurism standing out like a bud from the artery, and communicating with it by a small opening, would bear a resemblance to this machine, though not a strictly accurate one, since regurgitation would go on in the aneurism, which is not the case in the bellows.

In addition to this it may be remarked, that these small openings are sometimes, perhaps always, formed by the giving way of small portions of the atheromatous wall of the vessel. Such small atheromatous patches are sometimes met with in long tracts of healthy artery, where the wall is thin and weak, and where, therefore, a small and weak sac soon forms, and is liable soon to burst.

It does not necessarily follow, however, because the wall of an aneurism gives way, that the tumour therefore bursts. The process is usually a gradual one; and as the old wall is thinned and absorbed, inflammation proceeds in the tissues surrounding the sac, and, by condensing them, supplies the tumour with a new envelope. On minute examination of most large aneurisms, it will become evident that portions of their sac are formed by cellular membrane, muscles, and other tissues, which have originally been distinct from the tumour. In other cases, and especially when the tumour has perforated a bone, its sudden increase marks the occurrence of a large rent in its walls, and the supervention of a large consecutive aneurism upon the original disease.

Another very important element in the condition of the sac of an aneurism is the nature of the parts by which it is surrounded; since, when the tumour meets with the resistance of bone or other dense tissue, the sac is absorbed or worn away; whilst, when it presses upon organs which are very sensitive, or whose function is important, reaction and inflammation are soon excited by the pressure of the increasing tumour; and in such cases, if the inflammation does not pass a certain limit, perhaps consolidation may ensue; otherwise ulceration will take place. A singular complication of aneurism is where the tumour projects into the cavity of a neighbouring vessel, usually the pulmonary artery, or one of the cavities of the heart. Here ulceration seems to take place early, unless the pressure of the sac produces death. When veins lie contiguous to an aneurism, they are usually closed by the pressure of the tumour. Cases, however, are on record in which an aneurism has burst into the cavity of a vein. The circumstance will be again referred to in the section on arterio-venous aneurism.

The changes which take place in the neighbouring parts are due either to the pressure of the tumour or to the inflammation which it excites. The growth of an aneurism is often so rapid, that the effects of its pressure are very striking. Veins are closed, nerves expanded and thinned, muscles stretched and wasted, bones roughened or perforated, and even the skin itself is sometimes so atrophied as to give way. When aneurism produces irritation in the surrounding parts, the latter may slough or suppurate.¹ The sac is also usually involved in the action, and then the aneurism is opened by the separation of the slough, or the bursting of the abscess. This is usually accompanied by fatal hæmorrhage; but it may lead to the spontaneous cure of the disease, as will be observed under that head. The great difference often observed in the progress of internal aneurism, according as it presses upon a mucous or a serous surface, has been well shown by Dr. Gairdner ('*Med.-Chir. Trans.*' vol. xlii.) The hæmorrhage produced by the ulceration of an aneurism into a mucous cavity, as the pharynx, œsophagus, or intestine, usually proceeds from a minute orifice, and occurs by small quantities at a time, the opening being very liable to obstruction by a clot; while the opening on a serous surface, as the pleura or pericardium, is often, perhaps usually, a large rent, through which rapidly fatal hæmorrhage takes place. Surgical aneurisms do not very often come into contact with either of these classes of membrane, but the synovial cavities bear a great analogy with the serous, in this as in other respects;

¹ A case of abscess forming over and opening into an aneurism of the aorta may be found in Broca, *op. cit.* p. 166.

accordingly, hæmorrhage from the bursting of an aneurism into a joint is generally rapid and profuse. Two cases of great interest will be found in Dr. Gairdner's treatise, in which the spontaneous opening of an aneurism through the skin was followed by healing of the orifice, and in one case possibly by a cure of the disease; and other instances are on record in which aneurisms have been accidentally opened without any ill effects—nay, in some with good effect, from relief of the tension. It is more usual for an aneurism to communicate with one of the large mucous cavities of the body than with any other part. Then the progress of symptoms usually is, that a slight hæmorrhage occurs, which both weakens and alarms the patient to some extent. The bleeding then ceases, whether from syncope, from displacement of parts creating obstruction, or from plugging of the opening by displaced clot; but this cessation is temporary: the fissure reopens and enlarges, and the patient dies exhausted after a few recurrences of bleeding. Sometimes the bleeding occurs in such a situation,¹ or in such quantity, as to extinguish life in a moment; but these cases are usually under the care of a physician. Surgical aneurisms, when they burst, usually open into the cellular tissue or into a joint. In the latter case bleeding is generally copious, and the cavity becomes so much distended that pulsation is felt in it. The bursting of an aneurism subcutaneously is usually accompanied by great pain, and by rapid and gradually increasing hæmorrhage, producing faintness and syncope; but the symptoms and treatment of these accidents will be more fully considered hereafter.

Another termination of a growing aneurism, which is frequently met with in those affecting the extremities, is by gangrene, the result of pressure. This takes the case out of the category of common aneurisms, and it must now be treated like any other tumour producing gangrene. Aneurisms may remain stationary for a long period, though this is extremely rare. Sometimes, after the apparent cure of an aneurism—*i.e.* after it has ceased to pulsate and become stationary—it will again commence to grow, and the pulsation will recur; and in a case of this kind, which has furnished a preparation to the Museum of St. George's Hospital, increase of size was noticed without any return of the pulsation.²

In that case the artery had been tied above the tumour, and the increase of the latter, which was very marked, from the size of a hen's egg to that of the egg of an ostrich, and which continued during twelve months, led to the suspicion that the diagnosis had been mistaken, and the disease not aneurismal, but malignant. However, the tumour became at last stationary and solid, and the cure lasted during the rest of the patient's life, about one year. After death, the accuracy of the original diagnosis was established. In this case the cause of the absence of pulsation was obscure; but pulsation may sometimes be absent merely in consequence of the position of the opening; and in some cases no bruit may be audible, the orifice being at the deep surface of the tumour, and the force of the stream probably broken by clots. Such was the case in a woman under Mr. Vincent's care at St. Bartholomew's Hospital, in whom an aneurism followed the occurrence of a longitudinal rent in the posterior tibial artery, on its anterior face. The sac being formed at the posterior part of the artery, the stream of blood seemed to enter it indirectly. Hence probably the absence of pulsation. Nor was there any bruit. The diagnosis, therefore, was only made, after a long course of treatment, by an exploratory incision, when amputation became immediately necessary. I am indebted to Mr. Moore for the notes.

The changes in the blood contained in the sac are even more important than those in its walls. They refer to the nature and amount of clot formed in it. It is this clot which, by strengthening the wall of the aneurism, enables it to resist the action of the heart, and so opposes further increase, and which, by its constant increase in size and density (fresh clot forming as the old contracts), encroaches upon and finally obliterates the cavity. As this is the only cure of which the disease admits, except by ablation or in the very rare case of spontaneous cure by sloughing,

¹ See, in the *Path. Soc. Trans.* vol. x. p. 84, two cases in which aneurisms of the abdominal aorta burst, and the blood was effused around, and constricted, the œsophagus in one case, and the duodenum in the other.

² Prescott Hewett, *Med.-Chir. Trans.* vol. xxix. p. 75.

it is to obtain the deposition of an efficient coagulum that all the efforts of surgeons and physicians in the treatment of aneurism are directed.

In examining an aneurism after death, two kinds of blood-clot will be found in it. The one, which lines the sac, and is usually very firmly united to it, is tough, more or less decolorised and laminated, much resembling layers of different-coloured leather. The laminae, and the differences of colour, obviously mark a gradual and successive deposition. This laminated coagulum is now frequently called, after Broca, 'active clot.'¹ The other kind is soft, amorphous, and red, something like currant-jelly, and is always found inside the former. This soft clot (otherwise 'passive clot') may be a mere post-mortem appearance; but it is no doubt often formed in aneurismal tumours during life. I entertain no doubt that the soft amorphous clot is the first stage in the formation of the laminated fibrinous coagulum; and that it must be so in some cases is proved by the fact that aneurisms are sometimes cured by pressure in a very few hours. Now in those cases there has been no time for the formation of laminated coagulum. The sac must in the first instance have been filled with soft clot, and it seems in the highest degree probable that the soft clot has often become gradually hard and laminated.² The formation of soft clot, however, is not a matter of the same importance as that of laminated coagulum; indeed, a too rapid deposit is perhaps in some cases to be deprecated, as leading to a delusive appearance of cure. It is liable to be either melted or washed away by the circulation, and then the tumour, which seemed to be cured, begins to grow again.

The least diminution of the circulation, as from pouches in the sac, from roughness of its walls, or from external causes moderating the impulse of the heart, will lead to the formation of tough fibrinous coagulum on the wall of the aneurism, though what is the exact physical cause of this coagulation is unknown. It seems to require for its commencement a diminution of the circulation, but not its entire stoppage; indeed, it sometimes seems to go on less readily when the stream is stopped altogether. When once this tough fibrinous coagulum is formed, it has a tendency to propagate itself through the contiguous layers of blood until the whole sac is full, unless the stream of blood should be too strong for it; and when once formed, the clot acquires greater density, partly by the inherent power of contraction possessed by fibrine, partly because it is, as it were, hammered out by the impetus of the circulation and partly by the vital contraction of the parts which form the sac. It is interesting to compare different parts of the same sac: here, fibrine accumulates in strata; there, all is worn away—the sac, the surrounding soft parts, the periosteum, even the bone. A careful study of the parts will generally prove this to be owing to the impact of the stream of blood, and to the resistance of the surrounding parts; the attrition to which the sac is thus subjected easily explains its absorption. In this process of absorption, it seems that the clot may also be involved; that is to say, that even laminated coagulum may, in some conditions of the sac, be removed—an effect which can hardly be attributed to anything but the action of the vessels of the sac upon it. But if the vessels of the sac can remove the clot, may they not also deposit it—that is, may not the laminated fibrine which lines the clot be an exudation from its vessels, rather than a kind of precipitate out of its contents? This is the opinion of some pathologists,³ who consider the process as somewhat analogous to inflammation. But if it were so, the internal layers of clot ought to be the oldest, having been pushed inwards by the increasing deposit; now every-day observation of their colour and consistence proves that they are the most recent. The exact cause, how-

¹ The name does not seem a very well-chosen one, since it is rather the process than the clot which deserves to be called active. Looking at such a clot, which has remained for years unchanged in a cured aneurism, one would be inclined to say that nothing could well be more *passive*.

² See Richet, 'On Aneurism,' *Dict. de Méd. et de Chir. prat.* vol. ii. pp. 282-295. In Mr. Wagstaffe's case, reported in *Path. Trans.* xxix. 73, where death took place about half a year after the cure of a popliteal aneurism by Esmarch's bandage, the clot was found to be simply solidified, without any lamination.

³ Colles, 'On Aneurismal Sacs,' *Dublin Quarterly Journal*, 1856, vol. xxi. p. 53; Wardrop, article 'Aneurism,' in Costello's *Cyclopædia of Surgery*.

ever, of the formation of laminated clot must be allowed to be obscure. It is enough for our present purpose to know that in an aneurism such clots have the greatest possible tendency to form, and will form almost inevitably to some extent when the full force of the circulation has been withdrawn. Even in tumours which are rapidly increasing, it is usual to find coagula in parts where the stream has been less powerful.

The nature of the connection between the sac and its lining of fibrine, is another obscure point in pathology. M. Broca, in an interesting passage of his valuable work,¹ endeavours to prove that the laminated clot formed in an aneurism possesses a certain grade of vitality, however low. But the facts which he adduces to prove the vascularisation of such coagula do not appear strictly applicable to aneurismal clots. John Hunter and Blandin have injected clots in arteries after ligature, and Kiernan in a concretion forming in a vein below a tumour; but in both these cases there are evident sources of vascular formation, which do not exist in a cured aneurism; nor have I succeeded in meeting with any unequivocal proof that vessels pass between the sac and its lining of coagulum, nor with any facts which prove that such clots ever share in the vital actions, inflammatory or otherwise, of the parts around them, except the partial absorption mentioned above, which very likely is an absorption merely of the watery parts of the clot; so that the cure by laminated fibrine, when once complete, may be expected also to be permanent. There are cases where, after apparent cure, the aneurism has reappeared sooner or later, and sometimes after many months of apparent inaction. In such cases it is probable that either the clot was not complete, but allowed circulation to go on through its cavity, or that a portion of it was of the soft, not the laminated, variety.

As to the statistics of aneurism as it affects the different arteries in the body, I do not believe we are in a position to make any statements worthy of credit. In Dr. Crisp's work may be found an elaborate table of all the cases published up to that date; and Dr. Sibson has since given still more extensive researches as to aneurism of the aorta. Such tables are of great interest and utility in some other respects, principally in reference to the usual course and termination of each class of cases. But they are useless for the purpose of showing the liability of individual arteries to disease, since they always include an unnatural proportion of 'interesting' cases. Thus in Dr. Crisp's table of 551 cases, the popliteal aneurisms (137) are nearly as numerous as those of the thoracic aorta (175); and adding femoral (66) to the former, the proportion of surgical aneurisms in the lower extremity would be greater than thoracic—an absurd conclusion. The only way to determine the relative frequency, with any approach to correctness, would be to take the unpublished and miscellaneous records of our large institutions, such as our hospital registers; and even this would not be absolutely correct, since, after all, it would only give the proportion among the working-classes. The point is perhaps hardly worth the trouble necessary to decide it.

SPONTANEOUS CURE OF ANEURISM.

Since aneurism is a disease which consists essentially in disturbance of the natural equilibrium between the force of the circulation and the elastic reaction of the arterial walls at the part affected, and since the blood which fills the aneurismal sac shows a strong tendency to coagulate when the full force of the circulation is diminished, it follows that the disease is one peculiarly easy to cure in favourable cases; for the coagula formed by the external layers of blood in contact with the wall of the sac soon acquire an organic connection with it, and thus strengthen it, and, if uniformly deposited, enable it to resist the impulse of the blood over its whole circumference, and thus to check the further progress of the disease. When this has been once effected, *i.e.* when the whole wall of the sac has once recovered its power of resisting the distending force of the circulation, coagulation will generally advance from without inwards until the whole sac is filled with solid fibrine. The process may of course be interrupted by anything which temporarily augments the force of the circulation, such as intemperance, disease, exertion, or perhaps even great mental agitation; or it may be retarded or suspended by internal causes which modify the coagulability of the blood.

¹ *Op. cit.* pp. 127 *et seq.*

Several conditions or modes of spontaneous cure have been pointed out by pathologists. 1. The most simple, and as it seems the most common, is the coagulation of the blood in the sac in consequence of mere retardation of the circulation. 2. Another cause of coagulation in the sac, once much insisted on by writers, but rarely if ever seen in nature, is the pressure of the aneurismal tumour upon the artery in the neighbourhood of the sac, whereby the entrance of blood into the aneurism is hindered. 3. Another method, which has often been proved by dissection, is the stoppage of circulation through the tumour by a piece of clot which has been washed into the mouth of the vessel as it leaves the aneurism, or even at some distance from the latter. This plugs the opening completely at first (at least in most cases), but increases gradually by a deposition of fresh fibrine, till the orifice is quite closed. The circulation is then diverted into the collateral arteries. 4. In some much rarer cases, a clot may be carried down into the artery above the tumour from an aneurism higher up, or the retardation caused by the latter may cause coagulation in the lower sac. 5. Another method of spontaneous cure is by suppuration and sloughing of the tumour; and it is believed that aneurisms may be cured by inflammation of the sac without suppuration.

The fact that few aneurisms are found without some formation of laminated clot upon, at any rate, a part of their circumference, shows how strong is the tendency to cure. Wherever the wall of the tumour is sufficiently strong, clot will form upon it during any temporary diminution of the force of the circulation; and this clot will encroach upon the cavity, and may form the nucleus for a complete cure. Unfortunately it usually happens, and especially in aneurisms situated near the heart, that this effort is only transient. Either the circulation, recurring with greater force, overcomes altogether the barrier set up against it, and reproduces the uniform expansion of the sac, or the sac has some weak point where the clot does not form, or the circulation in the centre of the tumour is too powerful for coagulation to go on there. The form of the tumour, and the nature and size of its orifice of communication with the artery, must of necessity exercise great influence on the probability of this event. Thus a tumour formed by a mere expansion of the artery (fusiform dilatation) will have a much more powerful stream passing through it than one which stands out from the vessel like a bud, and is attached to it by a kind of neck.¹ Tumours of the latter form are, it is true, comparatively rare; but the intermediate form, in which the dilatation is confined to only a part, and that not a very large part, of the circumference of the artery, are the most common—at least among surgical aneurisms—and are much more prone to spontaneous cure than the fusiform aneurism. Then the state of the mouth of the sac will exercise an effect on the stream. If the orifice be smooth, and the internal coat prolonged into the sac and free from deposit, the blood finds no obstacle to its passage; but in contrary conditions, with a rough orifice and coagula projecting into the artery, the force of the blood must be much broken. Some pathologists believe, with Cruveilhier, that clot is never deposited on the smooth wall of an aneurism formed by the healthy arterial coats simply distended; hence that tubular aneurisms never contain coagula if their lining membrane is smooth and healthy. It is very difficult to be sure of this. The figure on p. 25 shows that laminated coagula are at any rate sometimes found in sacs of this sort, and it is scarcely possible to discover what was the condition of the lining membrane at the point where the coagula were deposited.

The statement that aneurism is a mechanical lesion, and that its cure is to be sought by mechanical means chiefly, is not meant to exclude from consideration the advantage that may be derived from an increase in the relative quantity and coagulability of the fibrine of the blood. It is true that the attempts which have been made to induce coagulation directly by chemical means have as yet partially failed; but methods, such as bleeding and starvation, which increase the relative quantity of fibrine, and diminish the force of the circulation, have often succeeded by themselves,

¹ But though the stream is more powerful, its lateral expansion, *i.e.* the pressure on the wall of the sac, is much less so. Hence the fusiform dilatation rarely attains the size of the saccular aneurism, and is not prone to bursting.

and, when not pushed beyond what is prudent, form an important adjunct to some other plans of treatment.

The reader may now be asked to consider briefly each of the conditions or proximate causes of spontaneous cure spoken of above. The first is the mere retardation of the circulation. This may take place under conditions which it is impossible to foresee and therefore to produce; but the chief and happily always accessible requisite is *rest*, which has been frequently known to effect the cure of aneurism, whether external or internal, with little assistance from any other means.

Such cases are reported by Luke,¹ Bellingham² and Tufnell;³ and many others might be cited from the various authors who have treated this subject. Hence the first advice given by a medical man to a patient in whom he discovers the existence of aneurism is to keep quiet. It is a pity that this recommendation is not made more stringent. The patient, instead of being merely enjoined to lead a quiet life and avoid all causes of excitement, should be rigidly confined to bed and to the recumbent position. But a still more powerful remedy consists in spare diet, though this should never be used except as an auxiliary to rest.

The following case deserves notice as illustrating the possibility of cure even in a condition usually regarded as quite hopeless.⁴ A publican consulted Mr. Stanley in October 1847 for a large pulsating tumour in the right breast, which *was rapidly increasing*. The symptoms do not concern us here; it was diagnosed to be aneurism: and he was advised to go home and keep himself perfectly quiet. Accordingly, he went home, lay in bed for six months, and fed only on beef-tea, milk, and light pudding. At first the tumour seemed to grow; but from Christmas of that year its walls gradually got harder, the pulsation diminished in force, and by March 1848 were no longer perceptible externally. He then left his bed, having become by this time very pale, emaciated, and feeble. He lived very abstemiously for four years and a half, when a general election 'excited him to deviate from the tranquil and abstemious habits he practised.' He died of acute pleurisy after exposure. A large sac was found communicating with the aorta by an opening (1 in. by 1½ in.) just below the innominate artery, in the posterior wall of the vessel. There was only a cavity large enough to contain a horse-chestnut, the rest was all filled with firm coagulum. The tumour had been of enormous size (7½ in. from side to side and 4 in. vertically). The disease which proved fatal appears to have been quite unconnected with the aneurism.

Bleeding is also a powerful agent in this plan of treatment. It is a remedy now little used, in consequence of its abuse in the time of our fathers; but it may be permitted to us to doubt whether the reaction has not been carried somewhat too far. Doubtless the repeated and copious venesections of old times could hardly be otherwise than injurious. Valsalva, it is said, used to bleed his patients day after day till they were unable to stand, and could hardly raise their arms from the bed.⁵ This is an excess to which our modern habits, as well as the prejudices of our patients, would effectually prevent surgeons of the present day from resorting; and there can be no question of the danger and impropriety of bleeding, when so insisted upon.⁶ But the moderate use of venesection appears both rational and, as far as we can judge from recorded cases, successful. Bleeding seems to increase the relative amount of fibrine in the blood; nor does it appear, when moderately used, to lessen its coagulability; while its effect on the power of the heart and the rate of the circulation may be calculated with some approach to certainty. That this effect is transient is very true, but so is the action of all the cures for aneurism. A transient effect on the circulation is all that is needed for the formation of laminated clot, which will then,

¹ *Lond. Med. Gaz.*, May 1845.

² *On Aneurism*, p. 148.

³ *The Successful Treatment of Internal Aneurism*, p. 8.

⁴ *Path. Soc. Trans.* vol. v. p. 107.

⁵ Hodgson, *op. cit.* p. 145. Some writers have thought that the usual representations of Valsalva's practice are exaggerated; but it is clear, from Albertini's account (*Acta Acad. Bonon.* vol. i.), that its general principle is correctly understood.

⁶ I have met with no instance of the application of Valsalva's method, properly so called, in modern practice. In a case brought before the Pathological Society, by Dr. Broadbent (*Path. Soc. Trans.* xiii. 44), dyspnoea, the result of an aneurism of the aorta, had been much relieved by bleedings practised at rare intervals; but this is of course quite a different thing from Valsalva's treatment. Porter speaks of having bled to syncope, several times, a patient with aortic aneurism, and always with marked relief: *op. cit.* p. 82.

in favourable circumstances, go on to extend itself. Besides, bleeding has the recommendation that it can be repeated, and its quantity proportioned exactly to the condition of the circulation. The great objection to its use appears to be, that (in internal aneurisms especially, but in all aneurisms to some extent) the antagonism between the heart's action and the forces acting in the tumour has a tendency to cause stoppage of the heart, and death from syncope.¹ This is especially likely to happen in the fluttering action which succeeds copious venesection; and it is on this account mainly that bleeding is dangerous. Still, there are too many records by different, and those the most competent, observers, to allow of doubt as to its great utility, in some cases, although probably in this, as in so many other things, the acute judgment of Sir T. Watson has hit the mark when he says that venesection is only admissible so far as to reduce *excessive* arterial action. For this purpose it is certainly a more manageable and more certain agent than digitalis. Dr. Stokes has suggested a modification of Valsalva's treatment, in which the small and repeated bleedings which Valsalva prescribed are retained; but the diet is opposite to Valsalva's. 'It should,' says Mr. Porter, to whom we owe our knowledge of this suggestion, 'be light and very nutritive, but of course free from any material of a stimulating nature' (*op. cit.* p. 81). It does not appear that any marked success has attended this plan.

The medical means available for the cure of aneurism, beyond those just enumerated, are very few. Certain drugs which retard the circulation have been used for this purpose; but without much success. Digitalis is both dangerous and uncertain. The action of tartar emetic, or of copious watery purges, seems only to be to produce weakness, which can be done with less distress by the means above enumerated. Some of the alkaloids exert a remarkable influence on the heart's action; such are aconite and veratrum.² M. Bouillaud has published a clinical lecture³ 'On the Treatment of Aneurism by Iodide of Potassium.' Four cases are related, all of which were benefited and one was thought to be cured. I have not myself perceived any benefit from the use of this remedy, though I have occasionally prescribed it for long periods of time, gradually increasing the quantity to enormous doses. Still in the judgment of many competent observers it seems to have been very successful. The acetate of lead has been recommended by Dr. O. Rees⁴ on the authority of a case of popliteal aneurism in which no other treatment was employed, and the tumour gradually consolidated as the patient was brought under the constitutional influence of the drug. My own experience of this plan also is, I regret to say, negative.

It is possible that an aneurism, though beyond operative interference, may still be accessible to local applications (*e.g.* at the root of the neck, or in the chest); in such a case, ice may be applied to the tumour. Some surgeons use refrigeration, as an accessory to pressure, in the case of external aneurism. The method is one of doubtful efficacy. I have seen it tried occasionally, but without any effect. It should not be forgotten that gangrene of the skin has been so produced.⁵

It seems to follow from the above facts that when aneurism is beyond operative interference, the best thing that can be done is to keep the patient quiet in bed for months, and years if need be, avoiding all causes of excitement, mental and bodily; to administer a light, unstimulating diet, but without denying him sufficient nutriment; to keep the part in such a position as may rather impede the supply and favour the return of blood; to use venesection in small quantities, and carefully, when the circulation appears at all above the normal standard, which, it should be remembered,

¹ 'An apprehension has been entertained by some that a patient suddenly reduced to a state of syncope might never rally, and actually die of, or be killed by, the operation; and perhaps such a casualty might have occurred.'—Porter, *On Aneurism*, p. 83.

² On the action of Veratrum, see *Lancet*, vol. i. 1862, p. 21.

³ See *Brit. and For. Med.-Chir. Rev.* Jan. 1860. Another successful case is referred to in the *Am. Journ. of the Med. Sci.* Oct. 1865, under the care of Dr. Sewall of Canada. Here, however, starvation and absolute rest in bed were also employed.

⁴ *Lancet*, 1865, vol. i. p. 280. Another successful case is related by Dr. Daly in the *Lond. Hosp. Reports*, iii. 179, where, however, absolute rest and local cold were also used.

⁵ Broca, *op. cit.* pp. 249 *et seq.*

ought to be below that of health; and, finally, to surround him with an equable cool temperature. A cautious trial may be made of the acetate of lead, of the iodide of potassium, or of any of the drugs which act more immediately on the circulation; but I do not think that there is sufficient prospect of benefit from their employment to render it justifiable to insist upon their use to the prejudice of the general health. Some very gratifying cures have been wrought by such-like medical means; and although, perhaps, the cases will not be many, yet some lives will be spared by the judicious use of such means, which would be sacrificed were the opinion acted upon that the disease is a necessarily fatal one, for which art can do nothing. I would recommend to any person undertaking the care of a patient with aneurism, in whom surgical treatment is contra-indicated, a perusal of Mr. Tufnell's pamphlet 'On the Treatment of Internal Aneurism.'

The second method of spontaneous cure, above indicated (p. 35), is that in which the artery is presumed to be obliterated above the sac by the direct compression which is exercised upon it by the aneurism. It is thought that a tumour, arising by a narrow neck from the artery, may fall back, as it were, upon the latter and close the vessel. This conclusion is drawn from dissection of cases principally of popliteal aneurisms, which have advanced to a large size, and have then become obliterated by clot. I do not myself believe in the reality of this occurrence, since arteries generally elude with ease the pressure of tumours much more favourably situated to compress them than an aneurism lower down could be, as well as for other reasons. The preparations were probably specimens of cure by impacted clot.

It is, however, a matter of little practical importance (though no doubt of much pathological interest), since no one would dream of encouraging the growth of a popliteal or other accessible aneurism on the speculation of its ultimately curing itself by pressure on its own artery.

A more clearly proved mode of cure is that which is produced by the impaction, in the distal portion of the vessel, of a portion of clot from the aneurism. The occurrence of this circumstance in the arterial system in cases of fibrinous concretions on the valves of the heart, as pointed out by Dr. Kirkes, has now been universally admitted, and is a frequent cause of gangrene, of softening of the brain, &c. (see p. 20). It seems also to be a not infrequent cause of the obliteration of arteries below an aneurismal tumour, followed in some cases by gangrene of the limb (or by death if situated near the heart), in others by the spontaneous cure of the aneurism. The way in which this latter result is produced appears to be as follows: If a branch comes off from the artery between the aneurism and the part at which the clot is impacted, this branch may enlarge until it replaces the original artery, and the whole process may remain without result. But if no such branch comes off (as is the case in the great majority of instances, since the impaction usually occurs just as the artery leaves the aneurism), then the whole force of the heart, as far as it acts on the artery affected, is employed in dilating the sac, the artery above it, and the branches of the latter. Sometimes the sac yields to the force, and the aneurism bursts, especially under undue muscular exertion. If this does not take place, and the circulation through the limb is still to go on, the branch or branches above the aneurism, and their communications or anastomoses with the artery below it, must enlarge. When this is effected to a sufficient extent, the full force of the circulation is withdrawn from the aneurism, which will then usually undergo the process of coagulation. It is quite obvious that it matters nothing to this process how far below the aneurism the clot may be impacted, provided that no considerable branch comes off in the interval, since the intermediate portion of artery exercises no influence on the circulation, and may, for the purpose of this argument, be regarded as part of the aneurismal sac. This process of spontaneous cure is imitated in the methods of treatment which bear the names of Brasdor and Fergusson.

This plugging process may go on gradually as well as suddenly, as is proved by its being found occasionally complete in persons who have never presented the serious symptoms known to accompany the impaction of a clot in a large artery; and

still more clearly, by its being sometimes met with in an imperfect condition, the artery being lined with a tube of fibrine, which still leaves a small channel for the blood.¹ It seems possible that the existence of another aneurism higher up may sometimes effect the spontaneous cure of the lower one, either in consequence of clot being washed down from the upper aneurism into the lower, or into the artery as it enters or leaves the lower sac, or (as it is said) by the retardation of the current caused by the upper aneurism. It is difficult to be certain as to whether the latter mode of cure ever really occurs, though cases are on record which appear to prove its occasional occurrence. It is, at any rate, possible, since feebleness of pulse in the limb below is a constant symptom of aneurism. In the other case, *i.e.* when a piece of clot is washed out of an aneurism above, the process exactly resembles that which has just been described.

There remains another process by which aneurisms have been known to become cured; and this consists in the suppuration of the sac and the ejection of the whole tumour by a process of sloughing. In this process, as in other instances of sloughing, the artery, for some distance on either side of the gangrenous part, is closed by coagulum, so that hæmorrhage does not take place, as might have been apprehended.² Or, in other cases, the sac may slough, and the artery, not being thus sealed, may give way, and the patient survive the hæmorrhage thus occasioned; syncope is produced, and coagulation occurs during this syncope, sealing the mouth of the artery. This, at least, is Dr. Crisp's opinion, but it is doubted by Broca; nor do I find references in Dr. Crisp's work to the cases upon which such an opinion is founded. Inflammation without suppuration, in the neighbourhood of the sac, is also spoken of by Broca and others³ as an occasional cause of spontaneous cure. I have not been able to find any cases which are, to my mind, quite satisfactory. Some, as the case reported by Mr. Sidey,⁴ appear to have been cures by impaction of clot.

The surgical treatment of aneurism, as far as it is successful and rational, is merely an artificial imitation of these processes. The treatment by gradual and partial compression of the artery above the tumour, has no other aim than to imitate nature in the first of the processes described above, so as to slacken the circulation through the aneurism, and allow the blood in it an opportunity of coagulation. The Hunterian operation has essentially the same object, although it accomplishes it in a somewhat different way, and by obliterating a portion of the artery above the tumour puts a more decided, but at the same time more temporary, check on the current of blood. The treatment by sudden or total compression, also aims at suspending the circulation through the sac completely for a short period. The cure by flexion (Mr. Hart's method) aims at combining this first process with the second, in which the aneurism is compressed by the parts around it, and itself (perhaps) compresses the vessel. Sir W. Fergusson's plan of manipulation, or crushing, is derived from observation of cases in which the natural cure was effected, or attempted, by the impaction of a clot in the artery leaving the sac. Brasdor's method, so far as it is justifiable at all in practice, *i.e.* with the modifications hereafter to be described, is identical with this in its object, and rests upon the same pathological basis. Direct pressure appears to cure aneurism usually by displacing portions of the clot, and may perhaps sometimes act by setting up inflammation in the sac or parts around it, which leads to coagulation. Finally, the old method, by opening the sac and tying both ends of the artery, bears the strongest analogy to the cure by suppuration, and is, in fact, a kind of excision of the tumour.

The extent to which the deposit of clot in spontaneously cured aneurisms proceeds, is one of the most curious and beautiful instances of that power of adaptation which the many processes of disease in the body furnish in such abundance to our notice. Generally speaking, the fact of the completion of this deposit implies the entire obliteration of the aneurism and of the artery for some distance on either side of it;

¹ See *ATHEROMA*, p. 17.

² See the cases related by Hodgson, *op. cit.* pp. 103-5.

³ Richet, *Dict. de Méd. et de Chir. prat.* ii. 291.

⁴ *Edin. Med. Journ.* vol. iv. p. 768.

and so great are the resources of the collateral circulation, that any part of the arterial tube beyond the first three great branches of the aorta may be, and has been, obliterated without compromising the life of the patient. Thus, numerous cases of obliteration of the thoracic aorta below this point have been recorded; the innominate artery has often been successfully obliterated by nature, though only once as yet by art, and a case is even on record¹ in which the coeliac artery and all its branches, with the commencement of the superior mesenteric, were involved in the obliteration of an aneurism seated on the abdominal aorta, without any loss of vitality of the viscera, which must (although the fact is not stated) have been nourished from the phrenic arteries on the one hand, and the inferior mesenteric on the other.

But these great channels of vital supply, though in favourable cases they may be stopped in this gradual manner without loss of life, cannot be so without extreme danger. In rare instances, however, we see that the cure of the aneurism proceeds to such an extent as to insure the sac against the force of the circulation, but that a channel is still left by which the blood passes, as it used to do through the healthy artery.

Of this a striking instance is figured in Mr. Hodgson's work²—a tubular aneurism of the femoral artery which has been coated throughout with a thick layer of laminated fibrine, while a channel is left in the centre, through which the circulation has been carried on, just as if through the natural artery.

Another case of this species of cure was exhibited by the present writer to the Pathological Society, and may be found described in their 'Transactions,' vol. ix. p. 172. The preparation in St. George's Hospital Museum displays an aneurism of the coeliac axis, of which no complaint was made and no symptoms existed while the patient was under observation during life. It has been so far filled with laminated coagulum that the walls of the sac are everywhere of great thickness, and there is only a small portion in the centre in which the clot was loose and soft, filling it only partially, and no doubt formed after death. The three branches of the coeliac axis spring from the distal extremity of the aneurism, and are in all respects natural. There could be no doubt that circulation had gone on through the central part of the sac, which had thus replaced the original artery.³

Symptoms of spontaneous cure.—The symptoms of the occurrence of spontaneous cure in an aneurism appear to vary according as the cure is produced by the gradual deposition of laminated fibrine in the sac or artery, or is the consequence of sudden occlusion of the artery by clot. When it occurs by sloughing of the sac, the progress of the disease is of course entirely different. Usually nothing is remarked, except that the pulsation becomes less violent, the tumour less prominent, and the sac, when emptied by pressure on the vessel above, more solid and resisting. Soon afterwards, in a time varying according to their size and position, the anastomosing branches will be felt enlarging, in most cases of superficial aneurism. When this is the case, the cure is generally not far off. The aneurism will soon be found transformed into a solid tumour of much less than its original bulk.

Sometimes things go on differently; the cure being ushered in by symptoms of great severity, principally disturbance of the functions of parts supplied by the affected vessel, accompanied by more or less pain, sometimes very severe.

Thus in a case of spontaneous cure of aneurism of the innominate artery, reported by Dr. J. W. Ogle,⁴ the cure was ushered in by urgent head-symptoms, and complete unconsciousness. The carotid artery was found after death to have been obliterated; and no doubt the head-symptoms coincided with and were caused by the impaction of a clot in the vessel supplying the brain. In a case of aneurism of the right carotid, involving, perhaps, also the root of the innominate, treated by Wardrop's method, and reported in his work 'On Aneurism,'

¹ Hodgson, *op. cit.* p. 125.

² Plates to Hodgson, *op. cit.* pl. vii. fig. 4.

³ See also Sir Astley Cooper's case, related by Hodgson, *op. cit.* p. 134, and preparations from two cases in the Hunterian Museum, 1641, which is figured on p. 25, and Nos. 1687, 1688. The latter two preparations are a pair; they show aneurisms of the internal carotid on either side nearly filled with laminated clot. The history of the case extends over five years and is reported by Sir G. Blane. The symptoms were all cerebral: dimness of vision, diplopia, loss of appetite, maniacal excitement, &c. Benefit was always derived from bleeding, antimony, and abstinence.

⁴ *Path. Soc. Trans.* vol. ix. p. 167.

p. 98, may be seen the account of a similar seizure. 'The patient was taken suddenly worse and appeared to be dying; his countenance ghastly, and covered with perspiration; tracheal rattle, and inability to swallow.' Other severe symptoms were also present. He remained in this state for several hours, and then rallied. At the same time, it was noticed that the arteries of the right arm and forearm, which up to that time had pulsated more strongly than those of the left, had become pulseless. The only probable explanation of this train of symptoms is, that a portion of the clot in the sac had fallen into the subclavian artery and closed it. The arm was partly paralysed for some time; but ultimately the anastomosing vessels enlarged, and the patient was in all respects cured.

This process of cure by impaction seems generally to occupy a period of at least several hours; but it may be completed very rapidly.

A man was under the care of Mr. De Morgan at the Middlesex Hospital for popliteal aneurism, which was treated by compression of the femoral artery. This gave him so much pain that he was with difficulty induced to keep the instrument on, and Mr. De Morgan, at his urgent request, was about to tie the artery. The house-surgeon was sent for in the afternoon, as the man was complaining of so much pain that he insisted on taking off the instrument. The tumour was then seen to be beating violently. The pressure was removed. *Twenty minutes* afterwards, when he was again seen, all pulsation had ceased, and it did not recur. The tumour, which had been very tense and painful before, became softer; and in twenty-four hours the circumference of the knee diminished one inch. The pain and extreme tenderness subsided at once upon the arrest of the pulsation.

The process of spontaneous cure is very often interrupted. A portion of the sac becomes strengthened by the deposition of clot; but where the circulation is more active, the sac goes on expanding, and either bursts, or causes death by pressure on neighbouring parts. Often, too, the clot, once formed, is broken down by the force of the stream; or it has been known to be dissected off from the wall of the aneurism, and has been found inverted by the force of the current, so that the convex portion of the clot, which had been moulded to the wall of the tumour, was found turned towards its centre.¹

In cases where the history can be followed, it usually is found that such interruptions correspond to, and are occasioned by, some unusual exertion or emotion of mind by which the circulation is unduly excited, or some accident in which, perhaps along with a similar affection of the circulation, the tumour may have been directly injured. Reference has been made above (p. 32) to a case in which the clot continued for a long time to grow without pulsation. In Mr. Prescott Hewett's account of that case, the reader will be struck by the fact, that the cure was not previously a sound one; that the pulsation recurred twice at long periods after the operation; and that, therefore, the clot was probably formed under the influence of a too powerful stream of blood, and so might be looser and less resisting than laminated fibrine usually is. Besides, the fact that the patient was far advanced in phthisis might have modified the coagulability of the blood. Many other cases are on record, in which clots, both after spontaneous and artificial cures, have softened and appeared to become absorbed; but cases in which they grow without pulsation are rare.

After the cure of aneurism is completed, *i.e.* after the whole cavity is filled with laminated clot, no further change takes place in the swelling except a decrease in size, very perceptible at first, while the fibrine is in the process of contracting, and which proceeds slowly for a considerable time, until the clot has assumed its condition of greatest density, in which condition it may remain during the rest of the patient's life. By this gradual contraction of the clot, small aneurisms are reduced to a size imperceptible to external examination, and sometimes can hardly be recognised even by dissection. The collections which used to be described as 'steatomatous or atheromatous tumours of arteries' were probably small cured aneurisms. But in swellings of larger size the laminae of the clot remain distinct, though usually decolorised, during an indefinite period. Other changes, however, sometimes take place in aneurisms which appeared to be permanently cured. These, probably, depend on the imperfect or loose formation of the clot; though later on, the wall of the tumour takes part in the action. Thus the clot may be found softened and changed into a grumous material, or suppuration may take place,

¹ *Path. Soc. Trans.* vol. iii. p. 46.

perhaps from the irritation of this decomposing fibrine, and the whole mass be ejected. This took place a year after the apparent cure of the disease in a case operated upon by Sir W. Lawrence.¹ Finally, the clot has been found more or less mixed with cretaceous matter.

SYMPTOMS AND DIAGNOSIS OF ANEURISM.

The symptoms of aneurism may be easily inferred from its definition. A tumour containing blood and communicating with an artery will, in all ordinary circumstances, receive pulsation from the artery; it will be situated on the course of the vessel, and will be incapable of being removed from it; it will (so long as part of its contents are fluid) diminish in size when the circulation through the vessel is stopped by pressure on the artery above, while on the contrary, some increase in size may be sometimes observed when pressure is made below the tumour; and, after the circulation has been stopped and the tumour emptied as far as possible, it may be seen to fill again gradually, and in a certain definite number of beats of the pulse, when the pressure is withdrawn. Besides these symptoms, which may be observed in every case of external or surgical aneurism, the two following must be borne in mind, which, though not always to be found, are so constantly present as to make them of great value in diagnosis. First, that the pressure of the tumour, and the diverticulum which it forms for the arterial current, will usually cause a diminution in the force of the pulse on the affected as compared with the unaffected side; and secondly, that the pulsation is usually accompanied by a peculiar rough blowing sound, called the aneurismal bruit. The assemblage of these symptoms furnishes as decisive evidence of the nature of the disease as it is possible to have of anything not actually under our eyes; and as it is rare for those which are most characteristic to be absent in external aneurism, the diagnosis does not generally present any great difficulty. In internal aneurism, *i.e.* aneurism seated in the chest or abdomen, it is very different; the tumour is often imperceptible, or if perceptible by percussion, or even by palpation, yet the course of the vessels is so far from the surface, and the tumour may extend so widely, that it is impossible to be sure that the tumour corresponds exactly to the position of an artery. The pulsation is frequently imperceptible, or may be derived from the near proximity of the heart or great vessels, without any real connection with them—a frequent cause of error in the diagnosis of tumours, especially in the abdomen. It is impossible to stop the circulation above, and watch the tumour refilling; the inequality of the pulse on the two sides, though very useful as a corroborative symptom, may be produced by a great variety of other causes, and the aneurismal bruit is very frequently absent. Hence, while the surgeon can usually pronounce a perfectly clear and unhesitating opinion as to the existence of aneurism in the limbs, the physician is beset with so many difficulties, that although they in general pay more attention to diagnosis, and therefore may be presumed to excel more in that branch of our art, the ingenuity of physicians has not succeeded as yet in pointing out any unmistakable signs of internal aneurism; and in many cases, even where the strongest reason exists for suspecting its presence, it is impossible to come to a certain conclusion during the lifetime of the patient.

It is worth while to study the above-mentioned general symptoms of aneurism a little more in detail, particularly with reference to their bearing upon diagnosis. The diseases with which aneurism may be confounded are, tumours, or abscesses, lying upon the course of large arteries, and malignant tumours of bone, which sometimes pulsate from the development of large blood-cells in them; further it is necessary to distinguish between aneurism and a mere enlarged and relaxed condition of the artery, in which pulsation is much more perceptible than usual. In the first place, then, an aneurism is a tumour contained in a cyst, or sac; it is therefore separable from other parts, which latter, if no inflammation has taken place, can

¹ *Med.-Chir. Trans.* vol. vi. p. 204.

usually be felt to glide upon it, and is more or less movable according to the depth of its connections and to the extent of its base. Next, as to the nature of its contents. These are, perhaps, more commonly a mixture of clot and fluid than merely fluid blood, and it is rare, therefore, to find pulsation equally perceptible in every part of the tumour. The character of the pulsation, it must be remembered, depends on two things: on the nature of the contents, and on the condition of the orifice. The usual character of the pulsation of an aneurism is that of a wave, gradually swelling up and gradually subsiding. There is also a lateral expansion of the tumour, so that if the two hands be pressed on its opposite sides, they will be seen to separate as the aneurism expands. There is usually superadded to this general heaving, when the artery lies between the sac and the hand of the observer, a distinct line of more rapid and thrilling pulsation, which marks the course of the vessel. This may generally be observed very plainly in popliteal aneurisms which are growing towards the knee-joint, and have the artery crossing them. The heaving character of the pulsation in aneurism differs from the more rapid and simultaneous pulsation of all its parts in a vascular tumour, which pulsates from the presence of a number of large vessels, and in which, therefore, the movement commences at all parts of the tumour, instead of being propagated from one. It differs equally from the movement communicated to a tumour by a large vessel lying beneath it, which is simply a rise and fall. The extent and power of the pulsation in an aneurism depend usually upon the amount of clot in the sac; and thus the gradual decrease of pulsation may be watched from day to day, as an aneurism is becoming consolidated under the use of pressure.

Pulsation may be obstructed by clots lying about the mouth of the aneurism, and sometimes may be altogether absent, although the sac still contains fluid blood. These are the most difficult cases in respect of diagnosis, which is then inferential merely, and almost as obscure as in internal aneurism. The cause of the absence of pulsation in an uncured aneurism is often very obscure. In some cases it appears to be due to the obstruction of the mouth of the sac by loose coagula. In one case of popliteal aneurism, in which pulsation disappeared during the use of flexion, it seemed probable that rupture of the artery and of the aneurismal sac was the cause of its disappearance. A free rent in the sac, like the total rupture of an artery by violence, is usually accompanied by disappearance of pulsation. Sometimes the pulsation may even have disappeared, in consequence of the tumour having been spontaneously cured, and yet its size and interference with the functions of the limb may cause the patient to apply for advice to a surgeon who has not seen it during its earlier stages. In such a case as this the patient's account of the previous symptoms, if he be a person of intelligence, will be of great value, while, if he can give no account of the disease, the diagnosis will probably be uncertain.¹

The pulsation can be made to cease at once by pressure on the artery above the tumour—a character common, of course, to all tumours which derive their pulsation from the vessel, whether by continuity with it or not; whether aneurisms, enlarged glands, abscesses, or anything else pressing on the artery. Pulsation in an aneurism is always more powerful than in the arteries leading to it, while the sac contains much fluid. This is a consequence of the powerful reaction between the wave of fluid and the walls of the sac (see p. 30).

The gradual return of the tumour to its full size, after it has been emptied by pressure, the circulation having been stopped, is another feature very characteristic of aneurism; and it is important to note the variations in this respect, which will be observed in an aneurism as it is gradually filling with clot. The more fluid the sac contains, the more completely will it be emptied, and the more readily will it fill. As the deposit of clot proceeds, the beat becomes less forcible, and the tumour varies

¹ I can refer to at least three cases—one of a preparation in St. George's Hospital Museum, another in the Museum of the Royal College of Surgeons, and a third in private, in which the limb was amputated for a large tumour in the popliteal space, believed to be malignant, and which turned out to be a cured aneurism; and I know that this has occurred in several other instances. In some of these cases, however, the pressure of the tumour had produced gangrene, so that the operation was necessary.

less in size with pressure upon the artery. It should not be forgotten, that since pulsation is caused by the reaction which the parts around exercise against the impulse of the heart, it depends for its perfection upon the integrity of the sac; hence it is frequently not present at all when there is no sac, as in rupture of an artery before a sac has formed. So in aneurisms which, after advancing rapidly, suddenly burst with a large rent, the pulsation often vanishes completely; to recur, perhaps (if the accident is not fatal), when the rent has healed.

Having clearly before us the symptoms of surgical aneurism, the following rules may be laid down for its diagnosis from each of the affections above spoken of.

Diagnosis of aneurism from tumours pressing on the artery.—The greater number of tumours which lie against an artery do not cause any bruit. If they do produce any sound, it is a mere dull short beat, or 'thud,' as it is sometimes called, and may in these cases usually be imitated by pressing the stethoscope firmly on any large superficial artery. On the contrary, the bruit of an aneurism is usually a somewhat prolonged rasping or blowing sound, and cannot be artificially produced in a healthy artery.

The pulsation communicated to a tumour, or abscess, lying over an artery is an equable rise and fall, which ceases entirely when the pulse is stopped, and recurs at the first renewed beat of the artery as strongly as ever. The pulsation of an aneurism is generally a wave of fluid, which, on the removal of pressure from the vessel, does not attain its greatest height till after a certain number of pulses, and which causes not merely a rise and fall of the tumour, but also an expansion in every direction. The surest diagnostic sign, however, is that the tumour can be dragged away from the vessel, while the aneurism cannot; but this is not always the case, since the tumour may be too deep, or too tightly bound down by fascia, or too closely adherent to the artery, to be moved. To this it may be added, that if the swelling be an abscess, the symptoms of that affection will sometimes be present; but the occurrence of suppuration around, or in, aneurismal sacs must be kept in mind; so that too great stress should not be laid upon the symptoms of suppuration, as if they excluded the notion of aneurism; and in any case in which there is doubt whether the swelling is an abscess or an aneurism, auscultation should be carefully used, since the rough aneurismal sound will prove that, even if it be an abscess, the swelling communicates with the neighbouring artery.¹

Diagnosis between aneurism and pulsatile tumours of bone.—The diagnosis between pulsatile tumours of bone and aneurism is very difficult; so that many of our best surgeons have been deceived by the resemblance. The diagnostic symptoms are the following, but they are seldom or never all present together: 1. The bruit seems but rarely as well marked in pulsatile tumours as in aneurism, and is often altogether absent. 'It is true,' however, as Mr. Stanley remarks,² 'that in states of general anæmia, also in diseases of the aortic valves allowing of regurgitation, limited portions, or even the whole, of the arterial system, without organic change in the vessels, may impart to the stethoscope a murmur approximating to the bellows-sound of aneurism. And if, under such circumstances, a tumour should happen to form in any region of the body, so close to a large artery as to influence its pulsations, then, by the stethoscope, the bruit or bellows-sound may be recognised in the artery as forcibly as in an aneurism.' 2. The pulsation is usually more sudden, less heaving, and less expansive in the pulsatile tumour, and is equally forcible over the same space of tumour, whether the latter be large or small; while in aneurism the bulk of the swelling and the force of its pulsation increase and decrease together. 3. The condition of the

¹ Great caution is needed in dealing with tumours lying near large arteries. Broca (p. 147) relates that of the four successive senior surgeons of Hôtel Dieu, Ferrand, Desault, Pelletan, and Dupuytren, the others each opened an aneurism by mistake for an abscess, and Pelletan laid open a malignant pulsatile tumour, intending to perform the old operation for aneurism. Numerous cases showing the errors of diagnosis which have been made in cases of aneurism, and which are usually due to neglect of auscultation, may be found in a paper by the author, 'On Pulsating Tumours which are not aneurismal and on Aneurisms which are not Pulsating Tumours' (*St. George's Hospital Reports*, vol. vii.)

² *Med.-Chir. Trans.* vol. xxviii. p. 316.

bone with which the tumour is connected will often aid in the diagnosis. Thus, in Mr. Stanley's case ('Med.-Chir. Trans.' vol. xxviii. p. 318), a plate of bone was found in the walls of the tumour. In another, which I saw at St. George's Hospital many years ago, where a pulsatile tumour of the ilium projected in the buttock at the situation of the sacrosciatic foramen, and closely resembled in many respects an aneurism of the gluteal artery, the diagnosis was correctly established by observing fulness in the iliac fossa, the ilium being expanded on both sides by the tumour developed in it.¹ When an aneurism, on the contrary, eats through a bone, it simply chisels out a hole in it; so that if the sac can be emptied and made to collapse, the edges of the hole will be felt. 4. These pulsatile tumours of bone are usually cancerous; so that the general symptoms of the cancerous cachexia may be present, or some other cancerous tumour may be seen. In the pulsating tumour in the buttock just mentioned, the presence of hæmaturia at a later stage of the case revealed the existence of mischief about the kidney, which was found after death to depend on the deposition in that organ of a large mass of encephaloid cancer. It must be admitted, however, that the diagnosis between pulsatile tumour and aneurism is often a matter of the greatest difficulty, even if it be possible; and that the diagnosis of cases of aneurism unaccompanied by pulsation, is sometimes impossible.

Diagnosis between aneurism and aneurismal dilatation.—The diagnosis between an aneurism and a mere dilatation is usually quite obvious, at least between extreme examples of the two. The dilatation is generally unaccompanied by any distinct tumour or by any aneurismal bruit. It contains no clot, and hence may be completely emptied by pressure on the artery above, filling at once when that pressure is removed; and there is usually no interference with the pulse in the arteries below the disease.

TREATMENT OF ANEURISM. THE OLD OPERATION.

The medical treatment of aneurism has been discussed sufficiently for the purposes of a work on Surgery. It now remains for us to consider the various plans of local treatment which are in use in ordinary or encysted aneurism, and to point out, as far as our present experience enables us to do so, to what extent and in what cases each plan is likely to prove useful.

The first method of treatment, usually called the old operation, or the method of Antyllus, aims at the entire eradication of the aneurismal tumour.² The operation is thus performed: the artery above the seat of aneurism is to be commanded, if possible, by a tourniquet, or by the finger of an assistant, or Esmarch's bandage is to be applied; then an incision is to be made into the tumour, care having been taken to expose it by a sufficient dissection of the superficial parts, should these involve any important structures; the clots are then to be rapidly turned out of the sac, and the orifice by which it communicates with the artery is to be searched for; a ligature is then to be placed on the vessel above and below³ the aneurism. The opening of the vessel can be found by passing a probe from the sac, first upwards and then downwards. When the ligatures have ulcerated through the vessel, or have disappeared, and the cavity has been filled up by suppuration and granulation, the tumour is radically extirpated.

Such is the description, in general terms, of an operation which, thus stated, appears simple enough. Its difficulties, however, are often of the gravest character

¹ In Mr. Stanley's case also the tumour projected on both sides of the ilium.

² Perhaps I ought to mention another method of eradicating an aneurism, viz. by caustic. Thus Nélaton destroyed a small bleeding tumour, resulting from a ruptured traumatic aneurism of the palmar arch, by means of chloride of zinc (*Journ. de Méd. et Chir. prat.* May 1862). This method, however, can only be used on superficial tumours of small size and connected with small arteries.

³ Keyslère, a surgeon of Lorraine, but practising in Italy, and who appears to have reintroduced the method of Antyllus into Italy, used only one ligature above the tumour. Three of his cases are reported by Testa of Ferrara (who seems to have learnt the operation from him), of which two were successful. Mazotti, who had seen Keyslère operate, used two ligatures generally, but not always (*Pelletan, Clin. Chir.* vol. i. p. 142).

when the aneurism is deeply seated, when the artery communicates with its deepest part, or has two orifices of communication with the sac, and those at some distance from each other, and when the sac contains recesses or is closely united to the parts around. Besides its difficulty, it is often an extremely severe operation, requiring an incision of extraordinary length,¹ sometimes involving considerable hæmorrhage, and leaving an enormous cavity to fill up. The records of ancient surgery show that it used to be often a tedious and desperate proceeding, which sometimes proved fatal on the spot, and the success of which was at all times very uncertain. Hence it has been superseded in almost all cases, and few living surgeons have much experience of it. In popliteal aneurism, for which it used to be the only cure except amputation, it is now completely abandoned, having given place to milder and more certain methods. In femoral aneurisms, compression or the ligature of the external iliac would always be preferred; and so on for most of the common species of surgical aneurism. There are, however, some situations in which the old method still holds its ground in the estimation of at any rate some surgeons. In axillary aneurism it has been recommended by the high authority of Mr. Syme, and enforced by the example of his successful application of it. In aneurism of the gluteal artery, should that rare disease be met with, many surgeons would prefer cutting down on the sac and turning out the clot, especially in a traumatic aneurism, to the still more dangerous operation of securing the internal iliac artery;² and in traumatic aneurism at the bend of the elbow, if the disease resisted the proper application of pressure, it would perhaps be considered more safe to open the sac and tie the artery above and below, and would involve no more danger to life. Besides these, cases will every now and then be met with in which the diagnosis having been uncertain, the tumour is cut into with a view of tying the artery above and below it, if it prove aneurismal, or amputating, if it be cancerous.³ In some cases also after the bursting of the sac, or after a wound involving it, the artery can be secured in this way and amputation may possibly be avoided.⁴

The leading idea of the old surgeons in operating upon aneurisms was doubtless an erroneous notion that it was necessary to get rid of the clot, which they believed to have vicious properties. This error is of course exploded. Still, when the clot has been disturbed and exposed to the air, it is better to remove it; and thus a large cavity is left to be filled up, and the extensive suppuration which this involves accounts for a large percentage of the great mortality after this procedure. Gangrene was very common after the old operation for popliteal aneurism, possibly from the difficulty of distinguishing the parts from each other, and the consequent frequency with which the vein and sometimes the nerve also was included in the ligatures. Another and a very frequent cause of death was the great liability to secondary hæmorrhage involved in this method as it used to be practised on diseased arteries. When used for traumatic aneurism, this objection does not apply, since the artery is as likely to be healthy in the neighbourhood of the wound as in any other part; but spontaneous aneurism usually occurs in consequence of atheroma in that part of the vessel; it is probable, therefore, that the ligatures will be applied to a brittle, degenerated artery, and will cut it through before any union has taken place. This danger, it is true, accompanies the Hunterian operation also,⁵ though to a less extent, and there is more probability of finding the coats of the artery near the tumour sufficiently healthy for the application of the ligature in external than in internal

¹ In a successful case, Pelletan made an incision ten inches long in operating on a recent popliteal aneurism, which is not stated to have been of remarkable size.

² But the diagnosis must be made with certainty. See above, pp. 44, 45. In Mr. Syme's *Observations in Clinical Surgery*, 1861, pp. 165-173, will be found two interesting cases of gluteal aneurism, treated, one by the old operation, the other by ligature of the internal iliac artery, and both with success.

³ Gay, *Lancet*, 1868, vol. i. p. 780.

⁴ Birkett, *Med.-Chir. Trans.*, vol. i. p. 431. Cooper Forster, *Clin. Soc. Trans.* vol. i. p. 36. Holmes, *Brit. Med. Journ.*, Jan. 10, 1880.

⁵ Especially in the arteries of the belly. See the account of an operation on the external iliac artery by Sir W. Fergusson, *Med. Times*, vol. ii. 1855, p. 567. See also *infr.* on 'Abdominal Aneurism.'

aneurism ; but even in the arteries of the limbs the neighbourhood of the tumour is the most insecure place in which an operation can be practised ; and this was the main theoretical reason which set Hunter upon thinking of a new operation for aneurism.¹ The practical reason was doubtless the excessive mortality occasioned by the above-mentioned causes, and by the hæmorrhage during operation, which, in all cases where no tourniquet could be applied, was frightful, and sometimes instantly fatal,² and which was often severe even when the artery was commanded above the tumour, since, in a deep sac, it was necessary to let the vessel bleed in order to find its mouth. What the mortality was after this operation, practised as it usually was in the popliteal space, we have no means of judging, except by consulting the works of those surgeons who, like Pelletan and Roux, have left the records of their individual experience, and this, after all, furnishes very uncertain information. The mortality of every operation in ancient times must have been high, since the after-treatment was far more arbitrary and artificial than at present ; but what the proportion of deaths may have been we cannot now ascertain. Pott says of this operation : ‘ I have tried it myself more than once or twice ; I have seen it tried by others ; but the event has always been fatal : ’ and Wilmer of Coventry said that in the year 1780 there had not occurred in this country one well-authenticated case of success.

The risk of hæmorrhage during the operation is a very formidable one when no tourniquet can be applied. Mr. Syme, however, succeeded in several cases in getting through these dangerous operations without fatal hæmorrhage by the same expedient as he used with such success in tying the vessels for wound ; a proceeding to which the operation under consideration bears much analogy. The sac is first opened by a moderate puncture, which allows a finger to be introduced into the sac to feel for the opening of the vessel. If the puncture is not large enough, it is to be dilated so as to get in one and another finger,³ until the point is discovered at which the pressure of the fingers arrests bleeding. Meanwhile the opening in the skin is of course plugged by the fingers which have been thrust into it, so that no great gush of blood takes place. When the orifice of communication between the sac and the vessel has thus been commanded the sac is opened freely and cleared of clots. Then the vessel is raised with forceps, if it is fairly visible, and tied. If the artery is not exposed, the operator must keep his finger still pressed on the orifice, while, with the aid of his assistants, he scratches away the tissue that obscures it.⁴ Further reference to these operations will be made in the sections treating of Carotid, Axillary, and Gluteal Aneurism.

THE HUNTERIAN OPERATION BY LIGATURE.

The treatment of popliteal aneurism by ligature is one, and perhaps the most perfect, of the many discoveries of modern surgeons.⁵ It reduced a disease, which

¹ ‘ Mr. Hunter, finding an alteration of structure in the coats of the artery previous to its dilatation, and that the artery above the sac seldom unites when tied up in the operation for aneurism, so that as soon as the ligature comes away, the secondary bleeding destroys the patient, was led to conclude that a previous disease took place in the coats of the artery. . . Mr. Hunter, from having made these observations, was led to propose that the artery should be taken up at some distance from the diseased part, so as to diminish the risk of hæmorrhage, and admit of the artery being more readily secured, should any such accident happen. The force of the circulation being thus taken off from the aneurismal sac, the progress of the disease would be stopped ; and he thought it probable that if the parts were left to themselves the sac with its contents might be absorbed, and the whole of the tumour removed, which would render any opening into the sac unnecessary ’ (Hunter’s *Works*, vol. iii. pp. 596, 598).

² Roux, *Quarante Années*, &c. vol. ii. p. 46.

³ In one case the whole hand was inserted up to the wrist.

⁴ A good description by Mr. Erichsen of this operation will be found in the *Lancet*, 1868, vol. ii. p. 504.

⁵ It is not intended to assert that the practice of tying arteries is a modern invention. ‘ The Greek and Arabian physicians,’ says Mr. Hodgson (*op. cit.* p. 187), ‘ more especially Ætius and Paulus of Ægina, distinctly recommended the ligature of the brachial artery a few fingers’ breadth below the axilla for the cure of aneurism at the bend of the arm.’ But, like many surgical inventions of the ancients, it had been lost until its reintroduction by modern surgeons in a more complete and more practicable shape.

before was almost uniformly fatal, to the position of one of the most manageable of all serious surgical affections. It is true that in still more recent times a method has been discovered which is usually successful at even less risk to life; but this method of compression, though, as we shall see, it may commonly be reckoned upon in popliteal aneurism, may fail even there, and there are many arteries to which it is inapplicable; so that the Hunterian operation of tying the artery above the sac still is, and probably will long remain, the last resource of surgeons in the graver cases of aneurism. Of so great a discovery and so happy a triumph of our art over difficulties which we, who have been taught how to combat them successfully, cannot estimate in their full magnitude, the history is always interesting, and the right appreciation of the claims of rival inventors is a matter of no slight importance. Unfortunately the limits of the present work do not allow of an adequate discussion of this subject, so that all that can be said about it must be comprised in a very few words, and it is more with a view of avoiding ambiguity or difficulty in reading foreign books, than of writing a portion of the History of Surgery, a task which is not attempted in the present work, that the following brief account is inserted of the rival claims of Hunter and Anel to the honour of giving his name to the operation now in use. This operation consists in securing the artery by a single ligature at a distance from the sac, and between it and the heart. The student will always bear in mind in reading most of the modern French works on surgery, that they intend by the '*méthode d'Anel*' the same thing as English, German, Italian, and American writers do by '*the Hunterian operation*.' The essential difference between Hunter's and Anel's methods has been shown so often and so clearly, that although I think it necessary again to expose it in this place, this will be done only cursorily, and as little space as possible will be wasted upon a question which has become rather personal than scientific.

The old method of operating for aneurism has been discussed, and its radical error has been seen to be, that its authors confounded what is in reality the effort of nature for the cure of the disease, viz. the deposit of laminated fibrine, with the essence of the malady itself; and instead of striving to encourage and promote this deposit, thought it necessary to undertake a severe operation for the purpose of removing all such clots from the system. Another, and hardly less fatal objection to its general application, was, that as the old surgeons never contemplated the possibility of a cure of the aneurism without the entire suspension of the circulation, it was necessary, in their view, to tie the artery close above the tumour, and, this having been done, it was found out that the blood would usually escape from the lower end unless that was also tied.¹ The great merit of Hunter consists in his having avoided both these errors; in his having seen, *first*, that it was not necessary to turn the clots out of the aneurismal tumour, so that no incision was required to open the latter; and *second*, that it was not necessary to stop the circulation through it absolutely, but only, as he said, 'to take off the force of the circulation,' so that the artery might be taken up some distance from the sac, and therefore at a part where it would probably be found healthy; and further, in his perceiving that the ligature of the main artery of the limb does not involve the gangrene of the extremity, but that the anastomosing vessels may be trusted to carry on the circulation.²

From these considerations Hunter was led to propose the ligature of the artery at a point some distance above the sac for the cure of aneurism, the result of disease; and that he, at any rate, and his contemporaries thought that he was making a proposition of startling originality, is clear from the terms in which Bromfield commented upon what appeared to him its rashness and its dangers.³ That it was equally new to Anel's countrymen (although seventy-five years had elapsed since Anel's day, during which the operation devised by him might have been expected, had it rested upon any new principle, to revolutionise surgery), is equally clear from a perusal of the pleasant work of Roux.⁴ We read there, that while in England the great school of Hunter, and in Italy, Paletta, Vacca, and Scarpa, had everywhere spread abroad the use of the Hunterian operation, the old method was gaining ground more and more firmly in France, until M. Roux himself, after his return from England, reimported Hunter's operation, which, as we shall see, had been performed once by Desault. In fact, he

¹ But some of the old operators used, as we have seen, one ligature only (p. 45, note 3). This fact should not be forgotten, as bearing on Anel's claims to originality in his invention.

² This had, however, been previously taught by Haller (quoted in Scarpa, Wishart's Trans. p. 229).

³ See Hunter's *Works*, vol. i. pp. 547 *et seq.*

⁴ *Quarante Années*, &c. vol. ii. p. 89.

says that it was not without astonishment that the Paris surgeons heard of a practitioner at Angers having been rash enough to apply Hunter's method to a *traumatic aneurism in the bend of the elbow*; the very case on which Anel had operated. So utterly had the memory of this reputed discovery perished with its author. It may, however, be replied that, though Anel's operation failed to attract the same notice as Hunter's, this does not prove that they are not identical in principle; nor does it. Even if it were so, however, there would be no little injustice in passing silently over the merits of the man who excogitated the principle by profound reasoning, applied it in spite of searching hostile criticism, explained clearly the theory on which it rested, and succeeded thus in forcing the world's attention and imitation in favour of one who was quite ignorant of the true principles on which the cure of the disease must be founded, and who, for anything that appears to the contrary, was guided by pure chance to the selection, on perfectly false principles, of an operation which he never repeated, nor persuaded others to repeat. This would be so, had Anel even happened to stumble on the same operation as Hunter; but the truth is, that the operations are perfectly different,¹ and rest on different principles; and that while the one will probably succeed, the other will almost certainly fail in many cases where the aneurism is the result of disease.

The case on which Anel operated has been often quoted, and is very well known. It need not here be related at length. The facts were these: a man had received a wound of the brachial artery in venesection. It is said that a fortnight afterwards an aneurism formed, and the wound reopened and gave rise to hæmorrhage, which was arrested by compression; and that after this, the tumour became very voluminous. What length of time had elapsed, and what the state of the tumour was, when Anel undertook his operation, we are not informed. The operation consisted in exposing the brachial artery, tying it as near the tumour as possible, and applying 'the proper dressing and bandage.' We are not told expressly whether the blood in the sac was solid or fluid; but it appears clear that it was in the latter state, and that the only reason which Anel had for not opening the sac, and emptying it of its contents, was that he was able to empty it by pressure. That this was so, appears implied in his own observations on the subject. He says: 'Instead of tying the artery above and below the tumour, I only tied it above; and besides, instead of opening the sac, I did not meddle with it; not doubting that the blood which it contained would disappear, having the opportunity of passing towards the extremity of the limb, and that the sac once emptied would not fill again, but its tissues shrivel up, and the tumour thus disappear: and all this occurred as I expected.' It seems clear, then, that if Anel expected the blood in the sac to pass on towards the hand, that blood must have been fluid, and probably the 'suitable dressing and bandage,' which he says he applied after the operation, may have had quite as much to do with the cure as the ligation of the artery; and, after all, the case may have been cured by direct pressure, an event not uncommon in recent traumatic aneurisms at the bend of the elbow. This is evidently quite a different operation from Hunter's; the only principle it has in common with his, is that of leaving the sac unopened; and few persons who read without prejudice Anel's confused and obscure account of his operation, will fail to see that the reason of his not meddling with the sac was most probably that it could be emptied by pressure. This view is again supported by the fact that Heister, who followed Anel's account, and apparently spoke on the authority of his single case,² advised its application only in 'reducible' aneurisms. Thus it does not appear that there was much of novelty in Anel's method, since it merely consisted in leaving to the fluid contents of the tumour an exit by the lower end of the artery instead of tying the latter, just as Keyserle had done; and it may very fairly be doubted whether what novelty there was, was not a mistake,³ and whether Anel's case, in spite of its success, is not only another instance of haphazard good fortune. At any rate, the results which flowed from it before the time of Hunter did not seem to testify to the brilliancy of the discovery. The great learning and evident bias of M. Broca have only enabled him to adduce what he calls six instances of operations performed on this plan before the date of Hunter's first operation, a period of seventy-five years. Two of these are related in the loosest way by Brandi, as having occurred in the practice of some anonymous surgeon, and were failures. Of the others, one was of the temporal artery, and two others of the humeral, all most probably traumatic, and all very likely curable without

¹ No better proof of the radical difference between the two operations can be required than is furnished by comparing two consecutive pages of a writer who persists in calling Hunter's method the '*méthode d'Anel*;' see pp. 509, 510 of M. Broca's work. In the former page he is carefully and judiciously explaining the essential difference in their effect on the collateral circulation, and hence on the patient's chance of recovery; in the second (the passage commencing '*études maintenant*'), he has recurred to his habitual language, and speaks of them both under one common designation. To such an extent is this pedantry of error carried, that it is difficult at first to see that in the latter passage the common or Hunterian operation is spoken of under the name '*méthode d'Anel*;' while in the former the same term signifies the now disused proceeding which that surgeon adopted.

² Heister, *Instit. chirurg.* pars ii. sec. i. ch. xiii. § 20, Amstelod. 1739, quoted by Broca, p. 446.

³ It seems as if Anel expected that the sac would empty itself, and would not again be filled; being ignorant of the reflux current and of the cure by coagulation.

difficulty by very simple means. The sixth case is the celebrated operation of Desault. It would be impossible, without taking too much space from more important matter, to discuss this operation fully in its bearings upon the Hunterian method. It is sufficient to say, that it was performed on a case of popliteal aneurism of small size, strictly after the method of Anel, *i.e.* by tying the artery immediately on its entering the sac. It appears (notwithstanding what has been said to the contrary) to have been successful, at least in its immediate results: the ligature separated on the eighteenth day; the tumour burst and discharged its contents on the day following; this wound healed, and the tumour disappeared. The patient died eleven months afterwards of a disease of the tibia, which appears to have been totally unconnected with the operation. This, then, was precisely the same as Anel's operation, and therefore missed the second and third principles¹ illustrated by the method of Hunter; *viz.* that the artery may be tied at such a distance as still to allow circulation through the tumour, and that the previous increase of collateral branches is not necessary to avoid gangrene, and that therefore the artery may be tied at the most convenient spot.²

The practical objections to Anel's method may be thus summed up. It leaves no current through the aneurism except the slight and weak reflux flow from the artery below. Consequently the clot formed will most likely be soft and loose, and the tumour will suppurate. It places under the ligature a part of the vessel which is more likely to be diseased than any other portion. It is, in most cases, the most difficult of all methods of operation, since the artery is pressed back by the projection of the tumour, and is therefore at an unnatural depth,³ while the operator has not the guide for finding it which a probe passed out of the sac would furnish. For all these reasons it seems that in any case where Anel's method was feasible, the old operation would be equally practicable and more certain of success.

The foregoing observations will, it is hoped, suffice to justify the use in the context of the name of Hunter in describing the operation which he is not denied to have invented in the form in which alone it is now practised, to have first performed, and to have afterwards, in spite of much opposition, introduced into general favour. If these things do not give claim to an invention, it is hard to see how such an honour is to be attained.

The Hunterian operation consists in tying the artery on which the aneurism is situated at any convenient distance above the sac. The operation, as it is now

¹ See p. 48.

² It would be unjust to deny the merit of Desault in applying the almost forgotten method of Anel to the treatment of that most formidable affection as it then was, popliteal aneurism, and still more unjust to deny that the experience thence acquired might possibly, had he survived, and had Hunter not been in existence (in fact had all the circumstances been altered), have conducted him to Hunter's discovery; but it is monstrous to set up Desault, as M. Broca wishes to do, as the rival of Hunter, when, according to his own showing, Desault himself was quite content to pass as Hunter's scholar. 'With a self-abnegation,' as M. Broca amusingly says, 'which his English detractors have been unable to appreciate, this great surgeon, who then had become acquainted with the operation practised by Hunter, did not hesitate to adopt the precepts taught by his illustrious rival' (p. 454). Desault, in fact, was unaware of his title to the glory which M. Broca claims for him. As to the insinuation which M. Broca ventures to make, that Hunter was indebted for his operation to Desault by means of Assalini, who, according to him, was present at Desault's operation, and related its details to Hunter shortly afterwards in England, it refutes itself. The Hunterian operation was taken up nowhere more warmly than among the eminent Italians, who were proud of being of the Hunterian school, as we have seen above from the contemporary account of M. Roux. Had one of their number conveyed to Hunter from Paris the first idea of the operation for aneurism, we may be quite sure that he, or some of his compatriots, would have said so. Assalini, an Italian surgeon, was the only person present, as far as we know, both at Desault's operation and at the first operation of Hunter. It was mainly through Assalini that the new method of treating aneurism was brought into vogue in Italy. Assalini and all other Italians always speak of that method as Hunter's. Would this have been so had Assalini taught it to Hunter from what he had himself learnt of Desault? But the fact seems to be, that Desault's operation, which was not brilliantly successful, and which he did not put forth as original, attracted little attention from himself or anybody else; and that he had no desire, as he had certainly no right, to claim any priority over Hunter, whose teaching he, on the contrary, followed with great intelligence and great success in the single operation which he had subsequently an opportunity of practising.

³ I exclude the comparatively rare case of the artery being raised and flattened by an aneurism growing into the deep parts. But here also I should imagine that the difficulty of distinguishing the vessel would incline the operator to resort to the opening of the sac.

practised, differs in many important particulars from that which Hunter used to perform; particulars which have a most material influence upon its success, and which were impressed upon Hunter himself, and upon his scholars and successors, by the teaching of experience. Thus, Hunter used to tie the femoral artery at its lower part (in the fibrous sheath, called from that circumstance 'Hunter's canal'), an operation much more difficult and dangerous than the modification introduced by Scarpa¹ Hunter, in his first operation, brought a large part of the walls of the artery into contact by four broad ligatures, somewhat loosely fastened, conceiving this disposition to be more favourable to the closure of the artery, which he described as taking place by the process of 'first intention.' His own experience, however, soon taught him to modify his form of ligature, and to use only one string; and the more extended experience and research of his successors (among whom Dr. Jones² has deservedly obtained the first place) have proved to demonstration, that the best form of ligature is single stout thread, drawn tightly; accordingly no other form is any longer in general use, though widely different materials are employed by different surgeons.³ Lastly, Hunter was not at first at all careful to avoid including the vein with the artery in the ligature; but this was an error which he soon gave up. So that the more material improvements were devised by Hunter himself; and in principle the first operation which he performed was identical with all that succeeded it.

The effects upon an artery of the application of a ligature have been already detailed in a previous section of this work (see vol. i. pp. 360 *et seq.*) While the changes there described are going on in the artery itself, the process of cure is progressing in the aneurism. We have seen already, that on the withdrawal or diminution of the force of the circulation, the preponderance of the heart being abated, the process of spontaneous cure commences. The ligature acts to a certain extent as Valsalva's method acts; that is to say, it diminishes the force with which the blood distends the sac, and thus gives opportunity for the coagulability of the blood and the resilience of the parts to fill the sac with firm laminated clot, and so effect the cure of the disease. It differs, however, from Valsalva's method in this important particular—that its action is local instead of general, and is therefore incomparably more certain and more safe. As the process by which the aneurism is filled, and the changes which it afterwards undergoes, are to a great extent the same after ligature as in the natural process of cure, the reader is referred on that head to what has been said above. But to that account it must be added, that since the surrounding parts are suddenly relieved from tension by the withdrawal of the expansive force of the aneurism, their resilience, and the compression they exercise upon the tumour, play a much more important part in the cure after ligature than in the spontaneous cure.

While the aneurism is becoming consolidated, the collateral circulation is enlarging, to convey the blood into the parts below the ligature. The meaning of this term is as follows: when an artery has been tied at any given spot, the next considerable branch which leaves it above the seat of the operation, and in their degree the branches above this, feel an increased pressure, in consequence of the neighbouring column of blood having been barred in the principal vessel. Hence they yield to the increased impulse, and become distended. The collateral arteries, by means of which they anastomose with the branches of the parent trunk below the ligature, increase, and increase probably in a much greater ratio than the larger vessels, in proportion to the greater tenuity of their coats. The facility with which the capillary and other small vessels allow of changes of volume is well known.⁴ Thus a ready way is

¹ On this head, see the section on 'Ligature of the Femoral Artery.'

² *On Hemorrhage*. Reference may also be made to Lisfranc: 'Thèse de concours des diverses méthodes et des différens procédés pour l'oblitération des artères dans le traitement des anévrysmes,' Paris, 1834; South's *Chelius*, vol. ii. p. 219; Porta, *Delle Alterazioni patologiche delle Arterie*, &c., Milano, 1845.

³ The different materials used for the ligature will be discussed in the section headed 'General Observations on the Ligature of Arteries.'

⁴ The enlargement of the collateral vessels must depend upon the presence of sufficient oxygen in the blood, as well as the sufficiency of the vis a tergo of the heart. If the former be deficient, there is no attraction of blood to the capillaries in the distant part of the limb;

FIG. 6.—Anterior view of the Anastomotic Circulation after ligature of the superficial femoral artery for Popliteal Aneurism some years before. The aneurism having recurred, the external iliac artery was tied, of which operation he died in seventy-eight hours. The cure was said to have been complete during four years. (After Porta, pls. xii. xiii.)

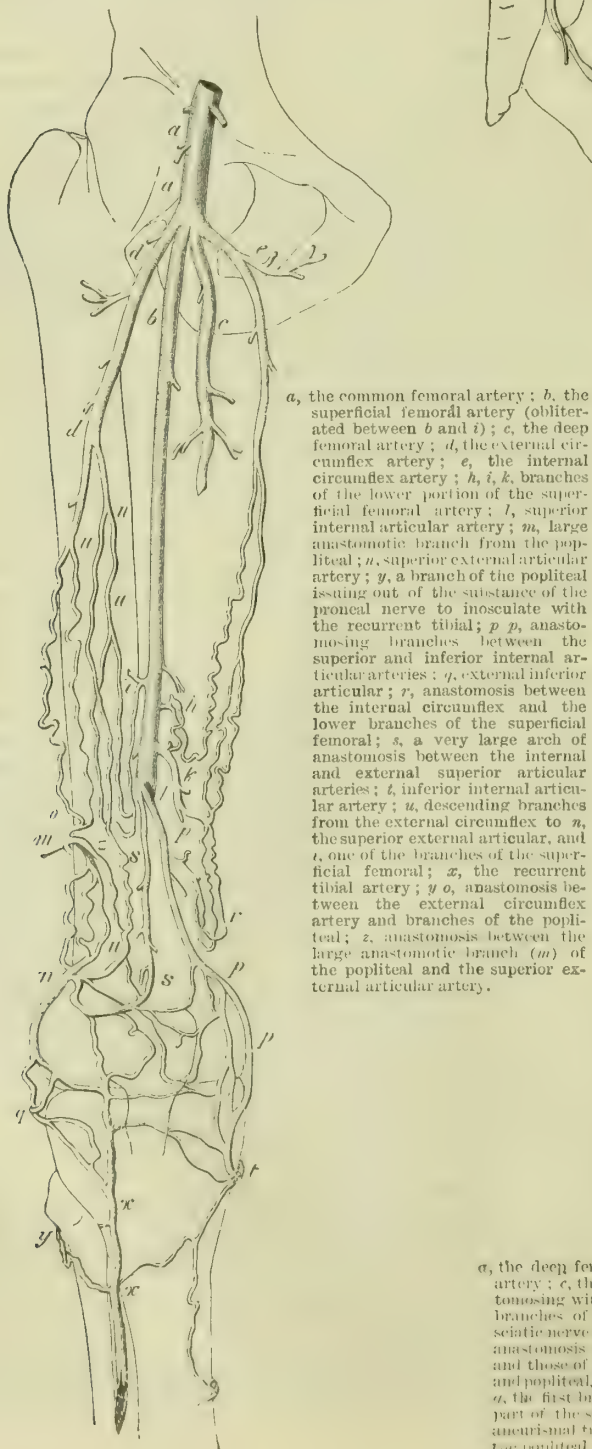
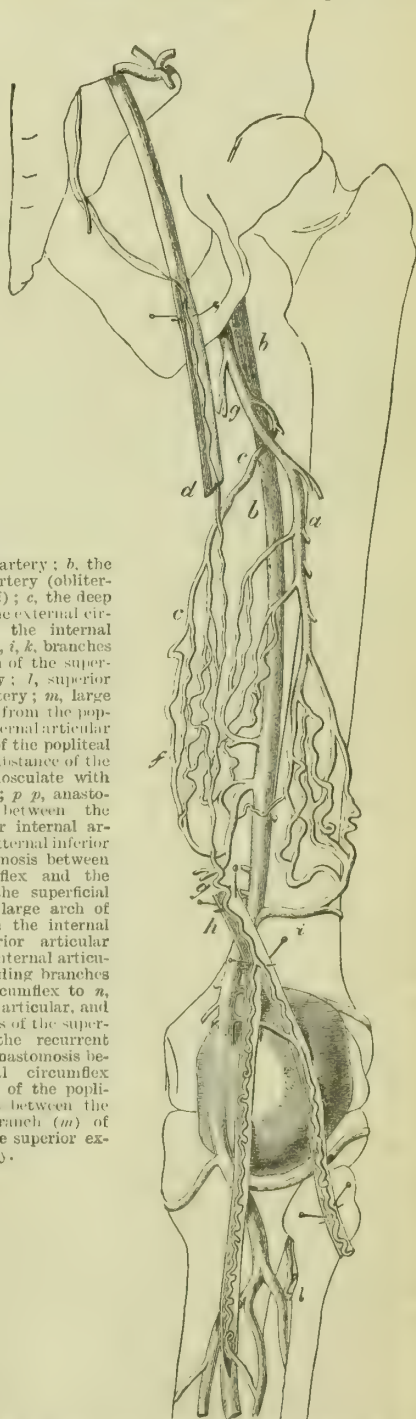


FIG. 7.—The posterior view of the preparation represented in Fig. 6.



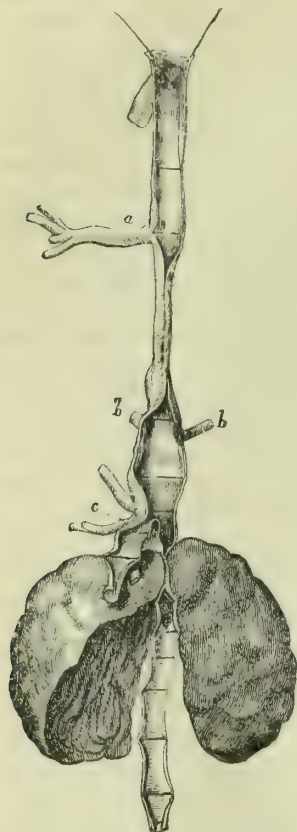
opened for the blood to return into the parent trunk below the seat of ligature. To make this clear by an example: say that the femoral has been tied (as it generally is) some distance below the origin of the profunda, in a case of popliteal aneurism. The blood will distend the profunda artery and its branches, amongst others the external circumflex and its descending branch; which, joining with the superior external articular, and thus with the anastomotica magna, will be one of the arteries to convey the blood round the ligature back into the trunk of the femoral, below the obliterated spot. The number of such collateral arches of anastomosis is uncertain, but probably they are numerous in most cases, and include, not named arteries only, like that above adduced as an example; but a number of muscular and other branches, the anastomoses of which are so fine in the healthy state, that they escape our ordinary methods of injecting. This is well illustrated by the accompanying illustrations taken from Porta's work, and derived from a case in which the collateral circulation had been too abundant, so that the aneurism had probably never been entirely cured, though the pulsation was not noticed by the patient till four years afterwards. As the aneurism was increasing, the external iliac artery was tied seven years after the original operation; but the patient died seventy-eight hours after the latter operation. The main point which this preparation shows is the extraordinary number and size of the arches of anastomosis by which the circulation has been carried round the obliterated part of the superficial femoral artery. It is, however, of some interest also as demonstrating the precise channels of anastomosis after this operation, which may be seen by studying the references to the plates. In fig. 8, on the other hand (as far as can be judged in the present state of the preparation), there seem to have been only one or two large arches of anastomosis, and in the Museum of St. Thomas's Hospital there is a preparation of ligature of the brachial in which the blood is brought down from the upper to the lower part of the vessel by a single branch the size of a crow-quill. Sir Astley Cooper, probably referring to this preparation and to one of a limb amputated seven years after ligature of the femoral, and described in vol. ii. of the 'Med. Chir. Trans.,' states his opinion that the number of the anastomosing vessels diminishes some time after the operation, until they give place to a few or possibly to a single vessel. But he gives no reason in support of this opinion, nor does it seem probable that any such diminution in the number of the vascular channels occurs. The effect of exercise and use of the limb is undoubtedly to enlarge the anastomosis; as may be inferred from the history of the case from which figs. 6 and 7 were taken.

The rapidity with which the collateral vessels enlarge cannot well be ascertained in the human subject. In animals it is known to be very rapid;¹ but in animals and a local asphyxia, followed by gangrene, must ensue. Deficient *vis a tergo* would show itself by pallor and coldness, with shrinking of the distal parts; a defective capillary attraction, with sufficient *vis a tergo*, would be shown in a stationary venous condition, perhaps livid congestion of the limb; while if the *vis* and the attraction be both wanting, the limb must be simply cold and inactive—in fact, dying. The integrity of the walls of the anastomosing vessels is also an important condition in the restoration of the collateral circulation.

¹ See the experiments of M. Broca, *op. cit.* p. 507, note. He placed a ligature under the femoral artery of a dog in the groin; then amputated the leg at the knee, and noted the distance to which the pulsating jet extended, both during the systole and diastole of the heart. The ligature in the groin was then tightened, by which, of course, the bleeding was stopped for the time; but it recommenced from the popliteal artery at the end of one minute, and at the end of five minutes the jet (which, however, no longer pulsated) had attained a quarter of its former maximum, even though the quantity of blood in the body was less. In an interesting case reported by Professor Otto Weber in the *Deutsche Klinik*, 1867, p. 285, he extirpated a tumour from the thigh. The femoral artery was so closely connected to the tumour, that after dissecting it as it went into the tumour above, he tied a ligature on it. He did not divide the artery then, but proceeded to dissect the vessels at the lower part of the tumour. Having exposed them, he placed a single ligature round both the artery and vein, without tightening it. The artery was noticed to pulsate strongly, and when opened, bled almost as fiercely as if it had never been tied. The ligature was tied, and the tumour removed with more than two inches of each vessel. The precise time between tying the upper end of the artery and opening the lower is not given, but could not have been many minutes. The patient recovered perfectly. In this case, as Professor Weber remarks, the collateral circulation had been doubtless enlarged by the pressure of the tumour on the main trunk.

the process of repair in all injuries of vessels is very far more active than in men, so that in them gangrene never follows on the ligature of arteries. No sound conclusions, therefore, can be drawn from this experience. In men, however, the process seems to advance sometimes very rapidly in the upper extremity, where the natural

FIG. 8.—Cure of Femoral Aneurism by ligature of the external iliac. (From a preparation in St. George's Hospital Museum, Ser. vi. No. 120)



The artery is seen to be obliterated for some distance at the seat of the ligature: *a, b b* show the enlarged collaterals on either side of the ligatured portion. The artery is again obliterated for a short distance near the aneurism; *c* points to enlarged collaterals, one of them of very large size, probably the profunda. The artery is seen to resume almost its natural size just below the aneurism.

anastomoses are free. Thus, in Anel's celebrated case, it is stated that the pulse could be felt at the wrist on the day after the ligature of the brachial. In Mayo's case of ligature of the subclavian,¹ the pulse was felt at the wrist on the fifth day, but disappeared afterwards; and in a case of popliteal aneurism operated on by Deschamps, pulsation was, it is said, felt in the sac seven hours after the operation.² On the other hand, in a case where the present writer had occasion to tie the axillary artery during an operation, the patient being a child, no pulse was perceptible in the radial more than a year afterwards. The enlargement of the collaterals has taken place to some extent before the operation in most, if not all, cases of aneurism, being occasioned by the obstacle to the circulation caused by the aneurismal tumour. The readiness of the return of pulsation will depend in a great measure upon the agents by which the circulation is restored. Thus, if one large branch join the artery below the ligature, the anastomosis being very likely effected principally by a single arch of artery joining this (as in Sir A. Cooper's case), pulsation will be restored quickly; if a large network of small branches carry on the circulation, it may be absent for an indefinite period. Whatever the period may be, it is certain that, in a few days at the latest, either gangrene will set in, or the circulation will be so far re-established that the blood will flow through the artery, entering it by the branch which joins it below the ligature, and probably by many of the successive branches. Thus, when the ligature has been applied far away from the disease, the blood returns into the vessel above the aneurism; and so, if the tumour be not already filled with clot, the circulation through it may be re-established. This circulation is sometimes sufficient to prevent coagulation and to perpetuate the disease; and failures from this cause are occasionally, but rarely, noted. More commonly, the force of the circulation is sufficient to cause a sort of undulatory movement to become perceptible in the contents of the tumour a few days after the ligature; but coagulation is advancing, and will rapidly suppress this movement, which soon ceases to

be appreciable. Now in these successful cases the anatomical condition of parts may be twofold. If the artery and aneurism form one channel, or if the aneurism

¹ *Med. Chir. Trans.* vol. xvi. p. 363.

² Wardrop remarks on this head: 'The enlargement of the anastomosing vessels, to a certain extent, takes place almost instantly after the trunk has been tied. I observed this in a child in whom I had secured the carotid artery. I could see the branches of the temporal and occipital underneath the delicate integument enlarging, and thus actively acquiring great additional vigour immediately after the operation' (*On Aneurism*, p. 12). As to the time at which the process is completed, the following is extracted from Porta, *op. cit.* p. 223: 'It is difficult to determine the time of the restoration of the collateral circulation after the ligature, inasmuch as it varies in different cases. Sometimes, after two or three months, the anastomotic circulation is so full, that it seems at the height of its development; while in

stand off like a bud from the artery, the canal of the vessel may be left pervious,¹ and the circulation will be carried on through it. But in the great majority of aneurisms, which are neither fusiform nor pedunculated, but sessile, and involving more or less of the circumference of the vessel, the obliteration of the tumour involves that of the affected artery; and now another arch of anastomosis will often be required. The necessity for the formation of this lower arch of anastomosis will depend on the distance between the point of ligature and the aneurism, and on the number of branches which communicate with the main trunk between them. If the point of ligature be distant, as in the common operation for popliteal aneurism, or if many branches intervene, the artery will be pervious between the ligature and the tumour (fig. 8), and therefore two sets of collaterals must be developed; one to carry the blood round the seat of ligature, the other round the aneurism.² If the point of ligature be near the aneurism, as is often the case in the external iliac artery, or if there be no branches, as in the common carotid, only one arch of anastomosis will be formed.

The immediate effect of a ligature applied to a main trunk is of course to suspend for the time the supply of blood and the vis a tergo of the heart. Hence congestion of the blood in the extremity, and hence temporary rise of temperature.³ Another immediate and necessary effect of the ligature is the temporary loss of power in the parts supplied by the obliterated artery. This phenomenon is not so often observed in men, since the conditions of their treatment prevent any attempt at movement of the limb operated on; ⁴ hence a tingling and numbness is generally all that is complained of; but it can easily be verified on animals. Thus, after ligature of the abdominal aorta in a dog, the animal will be noticed to drag his hind legs just as if he had received a severe injury to the spine. Sometimes in men, although the immediate paralysis may pass unobserved, its effects will persist, and a partial loss of motion in the limb will be permanent. Still more often the nutrition of the part is impaired, so that the member is thinner, colder, and weaker than the other. Gangrene, from accidental exposure to cold, may occur long afterwards in the toes in cases where the femoral artery has been tied, even when no symptom of gangrene has followed immediately on the operation. These unfavourable consequences should not be lost sight of in determining the question of ligature or compression. They

other cases, six or eight months afterwards (always compared with the healthy limb) it may be said to be hardly matured. From my observations, I am led to believe that the collateral circulation is developed in a limb operated on in the space of a few months, and generally before the end of the first year; because, on analysing specimens at remoter epochs, after 12, 18, 24, 36 months, it is not found that the anastomotic system has progressed farther. This system is fully constituted at that time when it has attained the aim of its development, and has brought up the circulation to the measure of the requirements of the limb, and so is brought to a standstill.'

¹ The latter disposition of parts existed in a case where Sir A. Cooper tied the external iliac. See the account of the dissection in *Guy's Hospital Reports*, vol. i. I have not met with a case of the former disposition after ligature; but it may be seen after spontaneous cure in Hodgson's case, quoted on p. 40; and after the cure by pressure in a preparation St. George's Hospital Museum, figured on p. 68. In the first case of ligature of the internal iliac, by Dr. Stevens, the pelvis was brought over to this country for dissection, the patient having survived the operation ten years. The account (by Prof. Owen) of the dissection may be found in *Med.-Chir. Trans.* vol. xvi., and there it is noticed that the aneurism (which was of the tubular kind) had in the centre a cavity containing only loose coagula; but no circulation had gone on through it.

² For a collection of several cases in which the femoral artery was found pervious between the ligature and the aneurism, see Wishart's *Scarpa*, pp. 263-4.

³ See Dr. J. R. Wood's case, in 'Report of Surgical Practice of Belle Vue Hospital,' *N. Y. Journ. of Med.* 1858, p. 239; and Sir W. Lawrence's, in *Med.-Chir. Trans.* vol. vi. p. 206. It will be remarked in the latter case, one of ligature of the external iliac, that though the ham on the affected side was warmer than on the sound side, the foot was always colder. It is interesting to observe that in experiments on animals this rise of temperature does not take place, the activity of the collateral circulation preventing even temporary congestion (see Broca, p. 507).

⁴ But sometimes slight and transient paralysis of motion or sensation is observed (see Mr. Chamberlaine's case of ligature of the axillary artery, *Med.-Chir. Trans.* vol. vi. p. 131).

depend in all probability on a defective development, either in size or number, of the collaterals, by which the nutrition of the parts is diminished, the conducting property of the nerves probably suspended, and the irritability of the muscles impaired. Mr. Liston thought that the excessive development of anastomosing branches running in the substance of nerves, such as the *comes nervi ischiatici*, might produce paralysis, and Porta in his description of the case from which figs. 6 and 7 were taken says, 'The great sciatic nerve, resting as it did with its two popliteal diseases on the convexity of the aneurism, must necessarily have been pressed upon, and it was to this position of the nerve, as well as to the great enlargement of the arteries running in its substance, that the habitual want of nervous power and the alternate pain and numbness must be attributed, which troubled the patient for years.'¹

*Causes of death after ligature.*²—The chief dangers following the operation are from gangrene and secondary hæmorrhage, excluding the complications to which all operations are exposed, and the special dangers which result in tying individual arteries from their anatomical relations, and which will be discussed in speaking of the special operations. Gangrene is perhaps a more frequent cause of death than hæmorrhage after ligature of arteries in the lower extremity.³ In the upper extremity, the anastomoses are so frequent, that the parts are nearly in the same conditions as in the lower animals, in whom gangrene is, as we have seen, unknown. The causes of gangrene are, a deficiency in number or in extensibility of the collateral branches, or a want of due care in maintaining the temperature of the part after the operation, constricting the limb with bandages, or, finally, some injury done to the principal vein of the limb during the operation.⁴ Little can be done to obviate the first cause of failure. It may be suspected, in persons of weak circulation and exhausted by old age or excess, that in the former case their arteries may possibly not anastomose very freely, while the latter class are nearly sure to labour under an atheromatous condition of the vessels. Hence both are bad subjects for the ligature of an important artery; but as these operations are now never performed unless under circumstances of urgency, in which all risks must be run, a knowledge of the state of the arteries, even if it could be certainly attained, would, after all, only affect prognosis. Much may, however, be done to prevent gangrene by maintaining the temperature of the part. It would seem at first sight inconsistent to

¹ Porta, *op. cit.* p. 381.

² In the last edition of this work reference was made here to the statistics of operations on large arteries as given by Norris, Stephen Smith, and others. These, however, I am glad to say, no longer give a fair idea of the results of the ligature. Since the improved methods of tying arteries and dressing wounds, the results have improved very considerably; but I do not think we are yet in a condition to give any useful statistics. The reader is referred to the sections on ligature of each individual vessel, for all that seems necessary on this subject.

³ Of fifty fatal cases of ligature of the femoral artery in Norris's table (*Contributions to Practical Surgery*, p. 285), twenty-three are stated to have died of gangrene and only eight of hæmorrhage.

⁴ That gangrene is often due to injury of the vein is an opinion which Mr. Syme has strongly insisted on (*Principles of Surgery*, 1856, p. 99). He even appears to go so far as to allege this as the only cause of gangrene, discrediting the received opinion (which has just been stated above) entirely. But that gangrene may occur when no injury has been done to the vein is proved by numerous facts. Amongst others, a preparation exists in the Museum of St. George's Hospital, with a record of a careful dissection by the late Mr. Gray, in which the vein was clearly proved to be perfectly healthy and uninjured, yet the patient died of gangrene. The vein has also been known to be included in many operations on the femoral artery without any symptom of gangrene. John Hunter at first purposely tied up the vein, and Roux has confessed to having done so accidentally. Langenbeck (*Archiv. für kl. Chir.* vol. i. pt. 1) and Gibson (*Am. Journ. of Med. Sc.* vol. xiii. p. 305) have both tied the internal jugular vein and carotid artery in extirpating tumours, Cooper of San Francisco (*New York Journ. of Med.* 1857, vol. iii. ser. iii. p. 410) the external iliac vein and artery in a case of aneurism, with good results, and other cases might be quoted to the same effect. The partial ligature of the vein, in which the thread is left like a seton in the cavity of the vessel, is much more likely to be followed by fatal effects. Mr. Carmichael and others have spoken of the occurrence of phlebitis and obliteration of the vein, sometimes followed by gangrene, as a consequence of injury to the vein (see Broca, p. 149).

talk of the necessity of keeping up the temperature in an extremity in which, as we have seen, it has already risen above the standard of health. But this contradiction is only apparent. The temperature of the toes rises after ligature of the femoral artery, not from increased power in the part, or increased vital activity, in which case it would clearly be wrong to add fuel to the fire, but from diminution of the vis a tergo of the heart, and consequent stagnation of the blood in the extreme vessels. Expose the part to cold—the tissues will contract upon and unload the vessels, which will themselves also be constricted by the cold—and the part will not only be deprived of blood, but a powerful obstacle will be offered to the weakened circulation by the rigid and contracted state of the vessels and the parts which support them; an obstacle which most probably will be found insurmountable. Hence the importance of maintaining the limb as near the natural temperature of the body as possible. It should not be much warmer, since parts in which the circulation is imperfect are as little able to resist heat as cold: thus gangrene has followed the application of hot salt or sand-bags to the limb. The best application is carded wool, which merely retains the natural warmth, and has the additional merit of retaining it without requiring renewal, while it allows the occasional inspection of the limb if required. It is advisable, however, to make such inspection only rarely, since it cannot be done without some change of temperature, which, if often repeated, might have a prejudicial effect. The wool should be used in large quantity, so as to form a thick layer around the whole limb, nearly as high as the seat of operation, and secured by a bandage loosely twisted round. It will be understood that the limb should be kept in such a position as to facilitate the return of blood.¹

The patient's diet and regimen should not be too rigid. This will of course be regulated by his previous habits; and the same may be said of the exhibition of opium. In persons of dissipated lives and nervous temperaments, stimulants and moderate quantities of opium must be allowed; while robust persons, with equable and tolerably strong pulse (who, however, are rarely the subjects of aneurism), will do better on a nourishing but unstimulating diet.

Gangrene, the result of deficient circulation, generally occurs from the second to the fourth day; but in some cases the limb does not begin to mortify till some weeks after the operation. In such cases of the latter kind as I have had the opportunity of observing, this has been due to inflammation of the sac and the parts around; leading to thrombosis of the neighbouring vein. When gangrene is unmistakably present, the case becomes grave; but the prognosis is not hopeless.² All depends on the rapidity with which the mortification advances. If, as is sometimes the case, it shows itself, not merely in the ends of the toes, but simultaneously on the dorsum of the foot, and advances with rapidity, no time should be lost in amputating, and the limb should be removed as near the seat of ligature as may be found convenient. It is not absolutely necessary to operate at, or above, the place where the artery has been tied. It seems to me best to wait until the gangrene is perfectly limited, and the patient has recovered, or is recovering, from the feverish condition which usually accompanies the onset of mortification, and then to amputate as near the ligature as possible.

When the gangrene, on the contrary, appears only in a limited space, and extends slowly in the continuity of the limb, hope may rationally be entertained of preserving the member. The case must be treated like any other case of gangrene, by local warmth, local and general stimulants, and opium, with due regard to the patient's constitution, nervous temperament, and general symptoms. Suppuration and sloughing of the sac is a kind of gangrene, and is one of the chief causes of death after ligature. It sometimes gives rise to hæmorrhage; but more frequently it poisons the blood, and leads to death either by pyæmia, or by that systemic infection of which pyæmia is the local manifestation.

¹ Mr. Guthrie's favourite method for obviating gangrene was to have the limb constantly chafed by the attendants.

² Of forty-nine cases of gangrene after ligature, fourteen recovered; ten of these without and only four after, amputation (Porta, *op. cit.* p. 394).

The other cause of death, that from secondary hæmorrhage, has been already treated of in the essay on INJURIES OF THE VESSELS, vol. i. pp. 362, 370.¹ It is more common in the upper extremity, where the heart is near, the circulation powerful, and the processes more rapid than in the lower. It is also more to be apprehended after ligature for aneurism, when the artery is more likely to be diseased at the point operated on, than for wound, when it will, in all probability, be healthy.

Besides these causes of death after ligature, the operation sometimes fails to cure the aneurism, though the patient survives. This, indeed, is rare; but it seems to occur in two ways. Either the pulsation never disappears in the tumour, and the latter, perhaps after a temporary check, continues growing in size, and will ultimately burst; or the aneurism diminishes, becomes solid, and undergoes a process of apparent cure, but then, after a longer or shorter period of quiescence, the pulsation reappears, sometimes with a sudden increase in size, and the disease is said to recur.

When the ligature fails to abolish the pulsation, this depends again on one of two causes. The artery may have connected with it a 'vas aberrans,' by which the blood is brought directly down into the tumour. Such was the state of parts in Sir C. Bell's case of ligature of the femoral artery.² This condition of the vessels, however, will not escape the attention of a careful and well-instructed operator; and the fact that tightening the ligature has not its usual effect on the pulsation of the aneurism, will show that the latter must either be seated on some other vessel, or, at any rate, must communicate as freely with another vessel as with the one tied. Accordingly this other vessel must be sought for by careful dissection; and until it is found the original ligature is not to be tightened. If there be a vas aberrans, the other vessel will be at no great distance, and should be tied at once. When this has been done, if pulsation is quite abolished in the aneurism, it will perhaps be unnecessary to tie the vessel first exposed; but it will be more prudent to leave the ligature (which has been already passed) under it, to be tied on the first symptom of returning pulsation in the tumour. These anatomical anomalies are so rare as to be merely surgical curiosities; still they should be borne in mind. It more frequently occurs that the circulation through the aneurism, temporarily abolished by the ligature, returns in a few hours or days, and continues to increase till it reaches its previous force, and the disease runs its course apparently unaffected by the operation.³ This accident must be due to the preternatural activity of the collateral circulation; and it is one which it is difficult to meet with appropriate treatment. In the first place, it seems reasonable that nothing should be done until the limb appears beyond the risk of gangrene, and until the pulsation is plainly permanent; and this cannot be said to be the case until the tumour has been pulsating very distinctly for some months, and the pulsation shows no tendency to abate. It should always be borne in mind that a slight undulatory pulsation in an aneurism on the second or third day after ligature is a very usual phenomenon, and so far from being of evil augury, is considered by many authors to be a favourable sign, rendering it more probable that laminated clot will form. It is assumed that, previous to the original operation,

¹ See also the sections on ligature of individual arteries.

² *London Medical and Physical Journal*, vol. lvi. p. 134.

³ The temporary return of pulsation is not so uncommon. Porta remarks on this head: 'Out of 448 cases of aneurism and aneurismal varix cured by the Hunterian operation, there was in twenty-five cases a relapse; that is to say, a manifest reappearance of pulsation in the tumour; but the pulsation was temporary, lasting from a few weeks to some months, and then disappearing. The case, however, above related of Miloni (the case from which figs. 6 and 7 were taken), and the two published cases under the care of Cooper and Roux, show that even in the thigh the anastomosis may enlarge to such a point as to annul the action of the ligature. Such cases are fortunately most rare. Relapse would occur much more frequently in the neck and elbow, where the anastomoses are naturally so ample and direct, were it not that the aneurism, however small, already contains some clot; and the blood, directly on the application of the ligature, being reduced for some days to the minimum of movement in the trunk operated on, ceases during that time to feed the tumour and the aneurismal artery, so allowing the obliteration of both by fresh clot' (*op. cit.* p. 385). The three cases referred to will be found in Porta, p. 378; *Brit. and For. Med. Rev.* vol. vi. p. 67; *Bolletino di Bologna*, an. xiii. series 2, vol. xi. p. 185.

compression of the artery above the tumour has either been tried and failed, or was contra-indicated. Hence it will be probably useless to recur to that method. Direct pressure (as by Esmarch's bandage), or genuflexion or forcible flexion of the elbow, if the aneurism be in the forearm, with appropriate bandaging of the limb, will of course be tried. When these measures fail, two courses are open—either to tie the artery lower down, between the ligature and the aneurism, or to perform the old operation of opening the sac and tying the artery as it enters and leaves it. As a general rule, the former method will be preferable in the lower extremity, the latter in the upper. Or if the surgeon has sufficient confidence in such measures, he may resort to galvano-puncture, or to the injection of perchloride of iron (see the sections which treat of these methods of curing aneurism). The ligature of the main trunk above the original seat of operation has been tried, but it appears to be contra-indicated both by theory and practice.¹

The recurrence of aneurism is, however, usually observed at a later period, after the persistence of the apparent cure for weeks or months. This was the case with a patient of Mr. Spence, of Edinburgh, in whom the aneurism was afterwards cured by genuflexion. The case will be found quoted on a subsequent page. It does not appear that the cure was ever a sound one after the ligature; and the pulsation in the aneurism was never abolished, though on the patient's first discharge it had been reduced to a line which was thought not to be more extensive than that of the popliteal on the other side. Cases such as this fail from the faulty formation of the clot. The sac is filled, not with laminated coagulum, but in part, at least, with mere soft clots; and these clots in the course of time soften and yield to the force of the circulation, or pass into its current. When this is the case, the affair becomes even more grave than when the disease recurs from the causes mentioned in the last paragraph, since the too rapid development of the collaterals is, after all, rather a phenomenon of over-vitality than otherwise; while, on the contrary, this indisposition of the blood to form laminated coagula under the usual conditions appears to testify to some profound alteration in the vital fluid itself. The prognosis, therefore, will be worse than in the latter case; but the treatment must be the same, since no more radical measures are at hand except amputation; and to this no judicious surgeon will have recourse until he is clearly certain that no other course is open. When, however, the ligature has certainly failed, and the case seems otherwise hopeless, no good can be expected from delaying amputation.

Such are the causes of failure, and the methods, at the best very uncertain of success, by which they may be met. But in the great majority of cases in which the patient survives the operation, matters progress quite otherwise. The wound heals and the part of the artery which has been occupied by clot degenerates into a fibrous cord. The tumour, at the same time, consolidates more or less rapidly; the undulating movement, which was perceptible in it at first, disappearing as the deposition of laminated coagulum advances, until at length the whole is consolidated, and then begins to shrink. Finally, as after the spontaneous cure, a small hard tumour remains, like a walnut, which, if cut into, displays a structure something like that of an onion. With the exception of the obliteration of the artery at these two points (for the persistence of circulation through or past the aneurism is rare), and the consequent development of collaterals, everything in the limb is natural. In other cases, the weakness and the faults of nutrition, which always attend at first upon the ligature of the main trunk of a limb, persist, and occasion atrophy of the muscles, fatty degeneration, &c.

Having discussed the mode of action and effects of a ligature applied to the main artery of a limb above the sac of an aneurism, as Hunter directed, it is perhaps necessary for me to express an opinion as to the cases in which this is indicated. The best formulæ, I think, would be as follows:

¹ As to the three cases mentioned in the previous note:—in Sir Astley Cooper's case the artery was tied close above the sac successfully: in Porta's case the external iliac was tied, but the patient died of the operation: in Roux's case no treatment seems to have been adopted.

1. It is indicated whenever the aneurism (which must always be supposed to be in an active condition, and advancing, or threatening to advance) is situated upon an artery inaccessible to pressure, but which will allow a ligature to be put round it without excessive danger, and with a sufficient space between the part tied and the tumour. Of these conditions the iliac and carotid arteries furnish the best examples. I do not mean that the iliac and carotid arteries cannot be compressed: but the patient very often cannot bear their compression.

2. When, in an aneurism differently situated, the patient, from nervous irritability, drunkenness, or any other cause, is intolerant of more gradual methods, such as pressure, genuflexion, &c.¹

3. When these methods have been tried and failed.

4. When an aneurism has burst into one of the internal cavities of the body, e.g. a popliteal aneurism into the knee-joint.

For a very interesting example of cure by ligature of the femoral, even after this formidable complication, the reader is referred to a case which occurred at the Middlesex Hospital, under the care of Mr. Moore, and which will be found reported in the 'British Medical Journal,' 1859, p. 489.

5. When the rupture has taken place subcutaneously, amputation or the ligature is generally indicated; still, in some of the less grave cases, it may be possible to obtain a cure by compression, but the attempt should not be too long persisted in; while, if the symptoms are urgent, or if gangrene have commenced, amputation is the only resource.²

Internal aneurism does not absolutely contra-indicate the operation, although it is a most powerful motive for avoiding it, unless it is believed necessary for the immediate preservation of life. Dr. Crisp (*op. cit.* p. 189) says that several cases are recorded where persons with aneurism of the thoracic aorta have survived the operation. But, in one celebrated case, the patient died on the table from rupture of an internal aneurism, just as the operation was being begun. This accident would now probably have been avoided by the quietness and absence of agitation produced by anæsthesia.

Contra-indications to the Hunterian ligature.—The late Mr. Aston Key has declared that, in his opinion, 'the only circumstance that ought to deter a surgeon from putting a ligature around any artery in the human body (not excepting the aorta) is, the uniform cessation of circulation in the parts below the ligature.'³ But, if we regard the preservation of the patient's life as the ultimate end of all operations, we must surely allow that any proceeding which is uniformly followed by death is unjustifiable, by whatever cause or causes death may have been produced; and, still more clearly so, if the disease for which the operation has been undertaken has been known to be cured by other means. To both these objections the operations for securing the aorta and innominate artery are fairly liable. On the first head, it may indeed be urged that the number of cases of ligature is as yet insufficient to allow

¹ Such intolerance must not, however, be too hastily admitted. Almost every person of ordinary good sense, and even of less than ordinary resolution, may be educated, by the gradual and transient use of digital pressure first, and the pressure of instruments afterwards, to bear the amount and duration of compression which is requisite.

² The subject of rupture of aneurism has been referred to above (p. 31). A paper by Samuel Cooper, in *Med.-Chir. Trans.* vol. xvi., will repay perusal. He points out that the pain is not always severe, that the shape of the tumour may be not much altered, and that, beyond a little purple discoloration, no trace of ecchymosis may be noticed. In these cases he is inclined to lay great stress upon the persistence of bruit, combined with the absence or gradual disappearance of pulsation, and a sudden fall in the temperature of the limb. Mr. Poland's paper, in *Guy's Hospital Reports*, 3rd series, vol. vi., contains notes of 42 cases in which the sac of a popliteal aneurism burst, and of the result of the treatment. In 2 no treatment was adopted; in 1 of these the tumour burst externally, but the patient survived the bleeding and recovered. In 24 compression was used; which succeeded in 2 cases. In 16 the femoral artery was tied: 10 recovered without, and 2 after, amputation; 4 died—3 of gangrene, 1 after amputation on account of suppuration of the sac.

³ *Med.-Chir. Trans.* vol. xiii. p. 8.

of our asserting that these operations are uniformly fatal. This is a point which must be left to the judgment of those who may be called upon to decide on the treatment of a case of this nature ; but on the second head there is no doubt. Aneurisms at the root of the neck and in the belly have often yielded to medical treatment or undergone spontaneous cure, while they have as yet never been cured by operation, except in one instance of traumatic aneurism, for which the innominate was tied. So that, if ligature be used at all in these aneurisms, it should only be as a last resort, when they have burst or are on the point of bursting, or when they are increasing under the best medical treatment which can be procured.¹ Again, the ligature should never be applied to any artery which is so situated as to admit of compression, unless that treatment has been tried and failed, or is contra-indicated by some peculiarity in the case. Nor should the ligature be used in cases of recent traumatic aneurism, particularly when caused by fracture, without a previous trial of the resources of nature, aided by such means as rest, position, careful bandaging, and pressure direct and indirect. Such cases, as we shall see, are peculiarly likely to undergo spontaneous cure. Nor should the ligature be used if the heart or a great part of the arterial system is diseased. In such case digital compression is the most appropriate and safest treatment.

ACUPRESSURE AND TEMPORARY LIGATURE.

This seems the most appropriate place to notice the proposals which have been made to treat aneurism by the temporary application of compression to the trunk of the vessel affected. These proposals, it is true, have not hitherto come to much ; but since Sir J. Simpson's suggestion of acupressure in surgical operations, the trunk-artery has been compressed in this way with success in a few cases of aneurism, and this has led to a revival in other forms of the temporary ligature, which proved unsuccessful in the hands of Scarpa, Clive, Sir P. Crampton, and the other surgeons mentioned by Mr. South (*Trans. of Chelius' System of Surgery*, vol. ii. pp. 218, 222).

A successful instance of the application of acupressure to the cure of a small traumatic aneurism in the ham (probably formed on one of the sural arteries) is referred to by Mr. H. Lee, in the 'St. George's Hospital Reports,' vol. iii. p. 33. Dr. Cheevers has recorded in the 'Boston Med. Jour.' Oct. 17, 1837, a case in which he applied acupressure successfully to the femoral artery in popliteal aneurism ; but the case was not cured in any shorter time than it would have been by ligature, and the patient seems to have run just as much risk—the artery having been freely exposed, and apparently somewhat roughly handled.

Prof. Porter treated a case of subclavian aneurism unsuccessfully by acupressure of the axillary on the distal side of the tumour. The man died not very long afterwards, and the vessel was found, not completely occluded, but narrowed ('Dublin Quarterly Journal,' Nov. 1867).

Numerous contrivances for the temporary occlusion of divided or exposed arterics have been introduced.

One of the neatest appears to be that recommended by Dr. G. Porter,² which bears some resemblance to an instrument devised by Sir P. Crampton and described in the passage of South's 'Chelius' above referred to, except that the agent of compression is silver wire. This is passed under the artery with an aneurism-needle, and is attached to a small frame made

¹ In such a case as the one in which Sir A. Cooper tied the aorta, viz. when the aneurism had opened externally, we may allow that the operation was the only conceivable means of giving the patient a chance for his life, and was equally creditable to the boldness and dexterity of the surgeon. If it be objected that the rules laid down in the text would prevent operations in the root of the neck altogether—since, unless the artery is tied early, it will be out of reach—I would reply, that this argument would show the ligature of the innominate to be an unjustifiable proceeding ; for in an early age of aneurism at the root of the neck, the patient has some chance of spontaneous cure, and a good chance of surviving a tolerably long period, while after the operation his life will, in all probability, be reckoned by hours.

² *Dublin Quarterly Journal*, 1868. This instrument was used for temporary deligation of the abdominal aorta by Mr. W. Stokes. See the same Journal for Aug. 1869.

of bent wire, and provided with a ring. The wire is drawn through the ring tight enough to stop the circulation, and is then fixed by twisting it round the ring. When the desired effect has been produced, it can be at once removed.¹

Our present experience of these plans tends to show that they have no real superiority over the ligature used in the ordinary way.

Brasdor's operation will be discussed along with the treatment of aneurism in the neck and thorax, where it is chiefly, if not solely, employed.

TREATMENT BY INSTRUMENTAL COMPRESSION.

The treatment of aneurism by compression is a practice of almost as old a date as that by ligature;² but, like it, had fallen out of use from certain imperfections in its details, until it was taken up again, improved, and fitted for practical use by modern surgeons. The old treatment consisted in the application of continuous pressure either to the sac, to the artery above it, or to both; and the cause of its frequent failure, or rather of the great rarity of its success in the hands of the ancient surgeons, arose from their ignorance of the natural process, as we have above attempted to describe it, which effects the cure of aneurisms. Not being aware that the deposition of laminated clot, when once begun, would go on, under favourable circumstances, to the entire obliteration of the sac in almost every case, and that, for the commencement of that coagulation, only a moderate check to the circulation would suffice, they always aimed at suppressing the circulation through the aneurism altogether,³ and if possible bringing the sides of the sac into the contact. It was therefore necessary, in their opinion, to use such an amount of pressure as could hardly be tolerated by any one of ordinary sensitiveness, and which, even if borne by the patient, was pretty sure to produce sloughing. It was from a similar ignorance of the curative powers of nature, and of the ease with which the nice balance between the force of the circulation and the reaction of the arterial walls may be restored, that the Hunterian operation, which had been recommended by the Greek and Arabian writers (whether practised or not, is another question), fell out of notice till that great surgeon re-invented it. Thus, in reading accounts of Guattani's cases, and of others in which the old surgeons attempted to cure aneurism by compression, we are at once struck by the fact, that the pressure was always either too severe or applied to the wrong part, and often both. For as they thought that the principal point was to exclude the blood from the sac, of course the chief means of doing so was to empty the sac by direct pressure. When this was impossible, the next thing was to compress the artery above so firmly that no blood could pass. The modern system of gradual and partial compression⁴ is entirely different in principle, and is a strict imitation of the process of spontaneous cure. We have seen that when an

¹ For other methods of making temporary compression on exposed arteries, see the authorities quoted in the *Biennial Retrospect of the New York Soc.* 1867-8, p. 214; also the American reprint of the second edition of the present work, vol. ii. p. 359.

² Heister is said to have been the earliest author who recommended pressure in the cure of aneurism, and Guattani the first surgeon who used it with success; but this was direct pressure. See Bellingham, *On Aneurism*.

³ It may be interesting to recall Hunter's case: 'The aneurism was in the femoral artery, and the swelling appeared upon the anterior part of the thigh, a little above the middle, extending upwards nearly to Poupart's ligament. An attempt was made, by compressing the artery above the tumour by means of an instrument somewhat resembling a steel truss, to give the blood in the sac a chance of coagulating, and by that means put a stop to the progress of the disease. But, from the pain which it occasioned, every attempt to make a permanent compression on the artery proved ineffectual.' He then proceeds to describe the progress of the case, the aneurism undergoing a spontaneous cure (Hunter's *Works*, vol. iii. p. 602). The pressure appears to have been applied too strongly, too constantly, and too much in one place. Yet Hunter was fully aware that the cure of aneurism was quite compatible with the persistence of circulation. Much more would surgeons who thought it necessary altogether to abolish the circulation fall into such errors.

⁴ The other and still more modern method of total compression during a few hours under anæsthesia will be spoken of afterwards. It was of course impracticable before the introduction of anæsthetics.

aneurism is cured spontaneously, it is in consequence of the circulation having received some partial check, by which laminated coagulum is deposited within the sac. Just so in the cure of aneurism by this method of compression. It is merely necessary to lessen the force of the circulation through the aneurism during some considerable part of each day, and then usually in a few days, but sometimes not till the end of several weeks, it will be noticed that the oedema and venous congestion have quickly subsided, and that pulsation is diminishing in the tumour, that its contents are more solid (which may be known by its varying less in size according as the blood is shut off or let in from the artery when the finger is pressed on it), and that the anastomosing branches are increasing so as to be felt pulsating. When these signs are present, we may be pretty sure that the cure of the aneurism is not far distant.

It would be wrong to pass over in silence the history of this method, although the length to which this essay necessarily extends prevents me from saying more than a very few words on the part played by the Irish surgeons in introducing the treatment of aneurism by compression, and on the gratifying success which has attended that treatment.

It has been noticed above that Hunter treated a case of femoral aneurism by compression on the artery between the tumour and the heart (indirect pressure); and the same plan was adopted by Sir W. Blizard,¹ and is strongly advocated by Mr. Freer;² but the latter surgeon, and probably all who preceded those of the Irish school, unless Hunter be an exception, thought that pressure was to act by obliterating the artery. The pain was very great, in consequence of the assumed necessity of making very firm pressure always in the same spot; nevertheless, some few cures were obtained under the care of Pelletan (or Echard), Dubois, Dupuytren, Boyer, and Albers, and are quoted in Dr. Bellingham's work; but these cases of success were balanced by failures, which, according to Dr. Bellingham, were 'still more numerous;' and the treatment was so painful and so uncertain, that it seemed likely to fall into complete discredit, until Mr. Todd of Dublin recommended the use of the plan as an adjuvant to the Hunterian operation; his object being, by preliminary pressure on the trunk of the femoral, to cause the dilatation of the collateral branches, and so to lessen the risk of gangrene. For this purpose he made use of the instrument originally invented by Heister; but no striking results followed from this practice,³ which was adopted by some surgeons in Dublin and decried by others, but regarded by all merely as an accessory to the ligature, until the accidental success of pressure applied in the case of a patient of Dr. Hutton's (Oct. 3, 1842), who refused to submit to the operation, shortly followed by similar success on a patient of Mr. Cusack's, whose health appeared too broken to enable him to survive the ligature, led to a better appreciation of the matter; and the striking success obtained in a patient of Dr. Bellingham's, the aneurism being cured in two days, drew the attention of surgeons in other countries to the matter, and successful cases followed, not only at Dublin, but also at University College Hospital under Mr. Liston's care, and in other parts of the kingdom. Still the great majority of the cases were treated in Ireland; and it is to the Irish surgeons, and especially to Dr. Bellingham, that the profession is indebted for the true theory of this method of cure. Their success in the application of the treatment has also been much greater than has been obtained in London. In Dr. Bellingham's small but very valuable work on Aneurism⁴ (from which the above particulars are extracted) may be found short notes of twenty-five cases (most of them treated in Ireland), in which compression was used, and which included all that had been reported up to that date. In only one of these was it found necessary to resort to ligature of the artery, and then not on account of the failure of the method, but in obedience to the wishes of the patient, who seems to have got tired of the treatment, though it appeared on the point of succeeding. (See also Tufnell's work.)

The experience of English surgeons has been far less favourable. In the 'Medical Times,' vol. ii. 1856, and vol. i. 1860, are to be found some valuable statistics of the cases which have been under treatment during late years in the metropolitan and provincial hospitals. Of the seventy cases included in the first report, which is believed by the reporter, Mr. Hutchinson, to be statistically accurate, as containing all the cases which had been under treatment, forty-six were popliteal aneurisms, treated by pressure. The treatment succeeded in twenty-four of them. Of the remaining twenty-two, in whom the femoral artery was tied, two only died of gangrene; while of ten cases in which the artery was tied without preliminary compression, three died of gangrene. The period of treatment in the successful cases varied from sixty hours to eight months, nineteen days being the average time. The large proportion of cases

¹ Bellingham, *op. cit.* p. 28.

² *On Aneurism*, pp. 94 *et seq.*

³ It is said, however, to have effected a cure in one unpublished case. (Tufnell, *On the Treatment of Aneurism by Compression*, p. 27.)

⁴ *Observations on Aneurism and its Treatment by Compression*. Dublin, 1847. I exclude two cases in which galvanism was also used, and one of which proved fatal.

in which pressure failed will strike the reader. It is probable that it was due to the novelty of the method; since in the second report, which contains fifty-nine cases, treated either by ligature or compression, the latter plan succeeded in twenty-five cases out of thirty-nine. Even this, however, shows a far less striking success than was at first augured for the method and might have been expected from the experience of Irish surgeons. It is possible that a greater proportion of cures may be obtained as surgeons become more acquainted with the method, and more alive to the necessity of attending to its minuter details.

The instruments required for the compression treatment are, one or two compressors, and a weight encased in leather. I shall describe the method as applied to the cure of popliteal aneurism; if the brachial or subclavian were the subject of compression, the modifications would be easily made. The compressors now in use are made on the principle of exerting pressure upon a small space, without any circular constriction of the limb. They consist of a plate or trough, which is applied to the lower surface of the thigh at the point opposite to the artery, and a pad supported on this plate by a strong lever, or arm, and movable in all directions. The lever stands well away from the thigh, and the instrument is kept in position by the compression which it exercises. When applied, it is screwed down upon the artery until the sensation communicated by the aneurism to the hand is considerably lessened, say diminished about one-half; and is left so until the patient is sensible of inconvenience from it. It is by no means necessary to stop pulsation in the sac altogether, nay, it is not clear that this expedites the cure, unless it can be maintained long enough to cure the disease at once—but for this purpose prolonged anæsthesia is usually required. Patients of quiet temperament and rather blunt sensibility can often tolerate for a time the degree of instrumental pressure necessary to stop the circulation; but it will generally be found that even in them it produces injurious consequences, either because the pressure acts on the vein as well as the artery and so causes œdema of the foot, or because the nerves become involved, or perhaps because the sac (which of course shrinks when most of the blood has passed out of it) becomes too violently distended on the withdrawal of the pressure, and so the process of coagulation is interrupted. It is better, then, when the instrumental method is employed, to commence with very mild pressure, to change the place of its application frequently, and to give the patient such intervals of complete repose as may refresh his spirits and procure him good sleep. The management of the compressor should be entrusted to some one who knows the course of the artery, and can judge of the direction in which pressure should be applied so as to command it. The course of the artery can be indicated by a line drawn down the limb with caustic, and any intelligent patient or nurse soon learns where to apply the pad; but the application of pressure in the right direction is more difficult.

Want of space forbids a complete account of the various kinds of compressors which have been invented for the treatment of popliteal and other forms of aneurism. Perhaps the best form, as obtaining the requisite degree of pressure with the least danger of producing a slough, and being, at the same time, least liable to slip, is Dr. Carte's apparatus (fig. 12), in which the arm carrying the pad is attached to the lever by means of india-rubber bands, and is movable in all directions on a ball-and-socket joint. It is very desirable, however, to have several instruments at hand, and to vary the point of pressure. The weight in the groin may be suspended by means of a string or wire, so as just to produce the necessary pressure without fatiguing the patient by holding it in his hand. Mr. Hart has contrived a plan by which the exact amount of pressure exercised is registered upon the compressor. This may be useful in preventing an excess of force from being unadvisedly employed. Much valuable information on these and other points connected with instrumental compression will be found in Tufnell's work on the subject. I append figures of some of the most useful compressors for aneurism. Carte's larger tourniquet is an excellent instrument for compressing the femoral in the groin. The smaller would be used to the common femoral, if possible, or to the superficial femoral when the patient was tired of the pressure in the groin. Skey's tourniquet is used for the same purpose, or for the brachial artery, but is less comfortable as wanting the elastic springs.

Signoroni's is intended chiefly for the brachial. Lister's (called also Pancoast's) is used for making pressure on the aorta or common iliac in cases of abdominal or iliac aneurism and in amputation at the hip (*q.v.*)

When the patient gets tired of the sensation caused by the pad of the compressor, he can lay the weight upon the femoral artery in the groin, raising it for a few minutes occasionally; or very often the patient prefers stopping the pulse by the pressure of the finger, thus combining digital with instrumental compression.

I entertain no doubt that when it is possible, it is very desirable to make pressure always on the same artery; so as always to call into action the same set of capillaries. For example, in using compression for popliteal aneurism it is desirable to make pressure only on the common femoral artery, and not to change from the common to the superficial femoral.¹ This, however, though desirable, is not necessary. The cure has often been effected, possibly more slowly, by making pressure in the groin and middle of the thigh alternately.

The general treatment during compression is a point on which some variety of opinion exists. Some surgeons, even in the present day, when stimulation is so much in vogue, prefer to adopt the depleting plan, although not to the extent recommended and practised by Valsalva; but the majority consider that the advantages, if any, derivable from this course, do not equal the difficulties which the restlessness, discomfort, and distress it occasions to the patient, throw in the way of the treatment. I have seen the depleting plan tried once, but it seemed quite inefficient, and the case

FIG. 9.—Signoroni's Tourniquet.

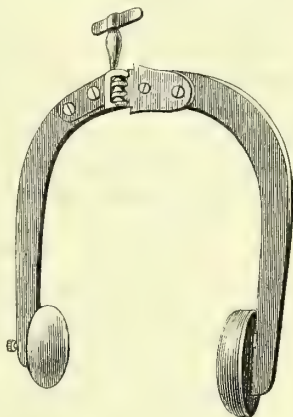


FIG. 10.—Skey's Tourniquet.

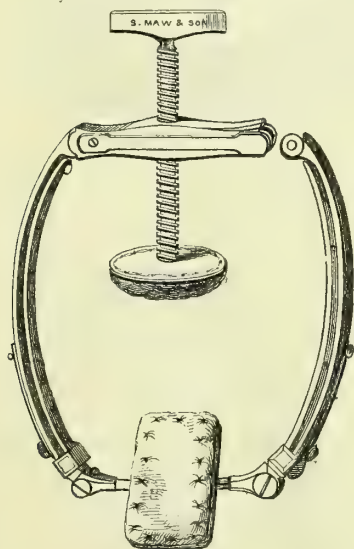
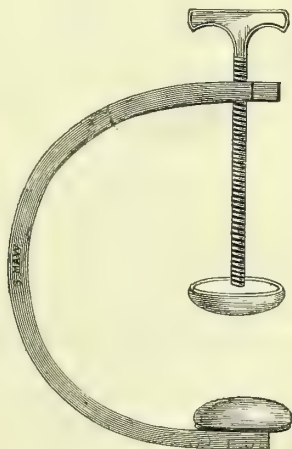


FIG. 11.—Lister's Tourniquet.



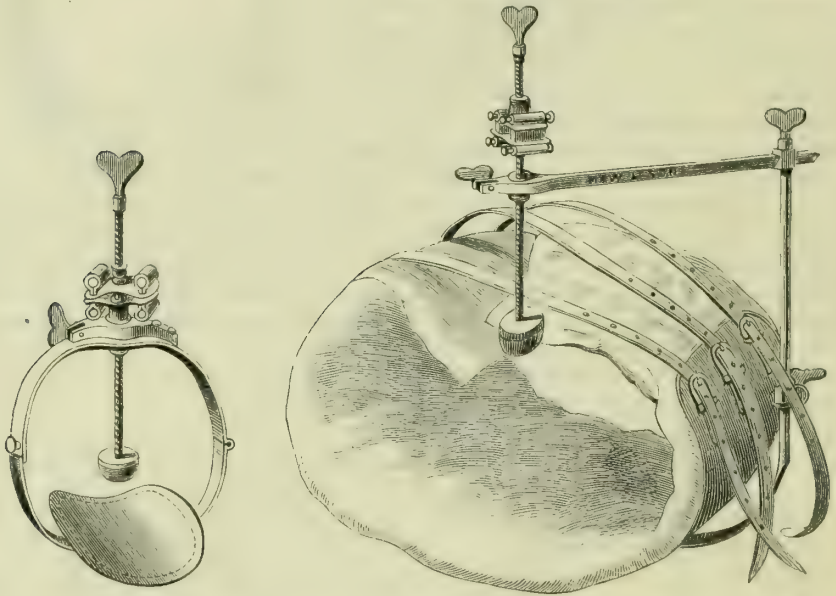
was the most protracted cure by compression which I ever heard of; while, on the other hand, a sufficient diet with a moderate allowance of stimulants, if the patient has been accustomed to them, appears not to retard the cure, and certainly renders him more disposed to submit to it. Some surgeons, acting on the idea thrown out by Dr. Stokes (see p. 37), prefer to feed the patient on a diet almost exclusively of

¹ See Walker, 'The One Artery System,' *Liverpool Med. and Surg. Reports*, vol. v. VOL. III.

meat, believing that the blood is thus made richer in fibrine, and more prone to coagulation. Opium is sometimes necessary to procure sleep; but, if the patient is not of an irritable disposition, and the pressure has been commenced mildly, he can generally sleep quite well when the instruments are withdrawn; and cases occur occasionally where the patient can sleep undisturbed even while the compressor is applied. It is well, in cases which are not urgent, to adopt Mr. Carte's suggestion of keeping the patient in bed for a few days, on equable diet, before commencing the pressure.

There are two main theories as to the best method of making compression in the cure of aneurism. The one adopted by the Dublin surgeons, as above referred to, is, that a slow current through the sac is, if not necessary, yet desirable, in order to the deposit of laminated fibrine; and that for this purpose the compression ought not to be applied to the artery tightly enough to stop the circulation. Consequently this plan involves a rather protracted treatment.¹

FIG. 12.—Carte's Tourniquet.



The other theory is, that if the blood can be completely arrested in the sac by compression stopping the circulation absolutely for some hours, the soft coagulum which is at first formed will gradually go on to complete induration and lamination, and the cure will be thus effected much more speedily and much more surely. The ample experience of the success of digital pressure in a few hours which we have now acquired, as well as the success obtained by pressure under anæsthesia in abdominal

¹ The time required for the success of the treatment by gradual compression varies remarkably. In 26 successful cases, reported in the *Medical Times and Gazette*, the time varied from 60 hours to 8 months, the average being 19 days. In some of the protracted cases, the cause of delay has been the inefficient way in which the treatment has been carried out. Thus in the case of a young woman who was under Mr. Prescott Hewett's care in St. George's Hospital, on account of popliteal aneurism, some years ago, the disease remained stationary, notwithstanding the constant application of pressure for months, but was cured in a few days after her transference to the care of a different nurse. It was discovered that the previous attendant had been in the habit of allowing her to remove the instrument and walk about the ward. In other cases, however, no such negligence can be detected, yet the cure makes no progress for a considerable time, when a favourable turn suddenly occurs, and the patient recovers rapidly. It seems impossible, with our present knowledge of the processes which go on in aneurismal sacs, to explain the reasons of these uncertainties; but the practical inference is, that as long as the tumour is not increasing, and the patient is not suffering from the treatment, it is reasonable and advisable to persevere.

aneurisms, during a variable number of hours,¹ have, I think, now convinced all surgeons of the practical superiority of the rapid method; and hence the gradual method of instrumental pressure is only used in those cases of external aneurism where digital pressure cannot be employed, or where this and other forms of treatment have failed, yet the ligature seems contra-indicated.

The total suppression of the current in the aneurism is best accomplished by making pressure below as well as above the aneurism; and in ordinary cases the pressure can only be borne by keeping the patient more or less fully under the influence of chloroform.

The cases to which the method by total compression is most applicable are those of aneurism in the abdomen, where digital pressure is impracticable, and instrumental compression so painful that the patient must be narcotised in order to tolerate it. It may be employed, however, in any aneurism; and in popliteal aneurism might perhaps be tolerated without chloroform. Here, however, the milder methods have been so successful that I should not myself be disposed to recommend it under ordinary circumstances.

Auxiliaries to the treatment by compression may be sought in position of the limb and in direct pressure; but these methods must not be insisted on if they appear to cause distress, and thus endanger the success of the principal agent of treatment.

Direct Pressure.—Signor Ciniselli has written on the use of direct compression in the treatment of aneurism, in the 'Annali Universali di Medicina,' 1867, vol. excix. p. 351.² Besides citing several cases in which direct pressure was used as an auxiliary to other means with apparent benefit, he refers to two in which it was the only agent used. One was a case of popliteal aneurism under the care of Bruncker, related in the 'Brit. and For. Med.-Chir. Rev.' Jan. 1840, in which pulsation ceased after five days; and the other a traumatic aneurism of the carotid under his own care, in which the pulsation disappeared after ninety-seven days. The agent of compression in both cases was a large piece of soft sponge firmly bandaged on to the tumour, and wetted once a day to give it the required elasticity. A still more interesting case is the one published by Dr. Buckminster Brown,³ in which a large femoral aneurism was cured by the application of direct pressure, very gradually, by means of weights (ultimately a 24-lb. cannon-ball) bandaged on to the tumour, at first in the recumbent position, but afterwards while the patient was taking active exercise. The cure occupied nearly six years (from July 1863 to May 1869), and its completeness was verified by post-mortem examination six years afterwards, when the aneurismal sac was found completely solidified.

When compression succeeds, the case is precisely on the same footing anatomically as when the disease undergoes the process of spontaneous cure, so that the reader may be referred to what has been said upon that head in a previous paragraph. Sometimes the artery becomes thickened and contracted where the pressure was applied, and it is possible that it might become obliterated; but changes in the arterial walls are of rare occurrence, and take place probably only when compression has been exercised more vigorously and more continuously upon one spot than is either usual or desirable.⁴ Usually when a limb is examined after the successful use of compression, the artery above the tumour shows no trace of its action (fig. 13). The tumour is generally quite firm, being filled with laminated coagulum; but some-

¹ See the *Biennial Retrospect of the New Syd. Soc.* for 1865-6, and for 1867-8, and a lecture by me at the College of Surgeons published in the *Lancet*, Oct. 10, 1874, p. 507. By a misprint in the second of the above cited *Retrospects*, it is said that a patient was kept under chloroform for 97 hours—9½ was the time. The longest period of pressure under chloroform yet recorded seems to have been 52 hours in a patient under Mr. Holt's care (*Clin. Trans.* vii 56).

² *New Syd. Soc. Biennial Retrospect* for 1867-8, p. 290.

³ *Boston Med. and Surg. Journ.*, Oct. 21, 1875.

⁴ In *Med.-Chir. Trans.* vol. xlv. p. 189 will be found a case in which a varicose aneurism formed spontaneously at the part where pressure had been applied to the femoral artery many months before for the cure of aneurism.

times a channel is seen, through which circulation has gone on in it. All this will be seen to be identical with the spontaneous cure. Enlarged anastomosing arteries are generally discovered, and this enlargement is usually and rightly regarded as one of the earliest and best symptoms of commencing cure.

The cure of aneurism by compression does not, however, always involve the obliteration of the sac, and does not, therefore, always involve the establishment of any new circulation. This point is illustrated by a preparation in St. George's Hospital Museum (fig. 14), in which a popliteal aneurism is preserved, which had been treated by compression of the femoral artery for more than two months. The sac lies between the artery and joint, and is entirely filled and laminated coagula, except a channel at the back continuous with the artery and forming a part of its tube. This method of cure is, however, not to be desired, since the clot may yield again to the force of the circulation,¹ and thus the disease may recur.

The failure of this method is due sometimes to the anatomical distribution of

FIG. 13.—Cure of Popliteal Aneurism by pressure. The artery remains pervious. The sac is seen to be filled with laminated coagulum. The asterisk points to the nerve spreading over the tumour. (From a preparation in the Museum of St. George's Hospital. Series vi. No. 121.)



FIG. 14.—The Femoral and Popliteal Artery from a patient who died about eighteen months after the apparent cure of an aneurism by pressure. The tumour had become stationary, and had given him no further trouble. The opening of the artery out of the aneurismal tumour is seen just below the letter *a*. The artery itself is perfectly pervious throughout; *b* shows the internal popliteal nerve. Almost the whole of the sac is seen to be occupied by laminated clot. (From a preparation in the Museum of St. George's Hospital. Series vi. No. 122.)



the arteries, as, for instance, when a *vas aberrans* carries on the circulation through the aneurism from a point above that which is compressed, and probably with more energy the more the main trunk is obstructed;² or it is due to sloughing of the skin under the pressure, to the patient's indolence or constitutional restlessness (by far the most frequent cause of failure), or to some deficiency in the tendency towards coagulation, which renders the blood in the sac incapable of going through the processes necessary for a cure without a more complete interruption to the circulation

¹ See Mr. Spence's case, quoted on p. 71.

² The case marked 24 in Dr. Bellingham's table (*Med.-Chir. Trans.* vol. xxxiv. p. 149) is an example of this peculiarity.

than gradual compression furnishes, and which must therefore be sought by total compression or by ligature.

It was at one time thought that, even if pressure fails to cure the aneurism, yet that it will place the patient in a better position for obtaining a cure by the ligature, in consequence of the dilatation of the anastomosing channels which it will produce. This doctrine rested on some statistics published in the 'Med. Times and Gazette' by Mr. Hutchinson. But I fear this is only one of the numerous errors which have been caused by the use of figures as the chief basis of reasoning in medical matters. I think that I have shown¹ satisfactorily that the irritation and delay caused by useless pressure more than counterbalance any such presumed advantage, and that the patient is in a worse, not a better, state for subsequent operation—an additional motive for not insisting too long on any form of pressure.

Compression sometimes does actual and visible harm, for cases do no doubt occur in which the aneurism increases with much greater rapidity after the application of the pressure, and goes on rapidly to bursting. In one such case the skin gave way and the patient died of hæmorrhage.²

The proportion of cases in which compression fails is no doubt very considerable in hospital practice, not much more than half the cases being cured. On this head I would refer to an interesting paper by Mr. Charters Symonds in 'Guy's Hospital Reports,' vol. xxv., where he gives the proportion of success in popliteal aneurism as 56·89 per cent., taking the whole practice of the hospital for fifteen years. But I entertain no doubt that this percentage might be improved by more continuous attention on the part of the surgeons in charge.³

As to pressure on the distal side of the sac, it appears in some cases to be very useful as an auxiliary to complete compression of the artery leading to the aneurism; but as the essential measure for the cure of the disease, it is not to be trusted. Still, trial may be made of this plan in aneurism at the root of the neck, where direct pressure might be dangerous, and where pressure between the heart and tumour would be impossible.

DIGITAL COMPRESSION.

The treatment of aneurism by digital compression is of very recent origin. It has sprung directly from the successes, and it must be said, also from the failures, of the treatment by mechanical compression.

The first recorded case in which digital compression was successfully employed for aneurism appears to be that of a patient treated by Mr. Greatrex in May 1844, and whose case was recorded by that surgeon in the 'Medico-Chirurgical Transactions,' vol. xxviii. p. 39; and another is recorded soon afterwards by Mr. Tufnell.⁴ In both these cases the pressure by the finger was employed as a temporary aid to instrumental compression rather than as a means capable of effecting the cure of an aneurism.

The first recorded case in which digital pressure was used as the sole method of treatment was under the care of Dr. Knight of Newhaven, in 1848, and was successful.⁵ Other cases soon followed in America, some of mixed digital and instrumental compression, others of digital compression only.⁶ The method was not used in Dublin till some years later.

In one instance, Donohue, a patient of Mr. Colles in the Meath Hospital, Dublin, observing that by compressing the femoral artery in the groin he eased the pain of a diffused popliteal aneurism, quietly performed the compression during three days, so that when the surgeon came to fit on a tourniquet he found that his patient had cured himself.⁷

In Italy, the first successful cases were published by Vanzetti, as having occurred in the years 1853 and 1855, and will be found in the 'Annali Universali di Med.' 1858; but Vanzetti claims for himself the real priority in the invention of the method on account of a case in which he treated a popliteal aneurism by digital pressure, at Karkof in Russia, in 1846;⁸

¹ *Lancet*, Dec. 12, 1874.

² *Med. Times*, 1860, vol. i. p. 118.

³ See *Lancet*, May 1, 1875.

⁴ *Dublin Medical Press*, 1847, vol. i. p. 169.

⁵ *Transactions of the American Medical Association*, 1848, p. 169.

⁶ Fox, *American Journal of Medical Sciences*, 1849, vol. xxxvii. p. 377; Willard Parker; Broca, p. 809.

⁷ *Dublin Med. Press*, 1852, p. 217, 1854, p. 97.

⁸ *Priorità del Metodo di curare gli Aneurismi colla sola mano, dovuta alla Scuola di Chirurgia dell'Università di Padova, del Prof. Tito Vanzetti.* *Annali Universali*, vol. clxiii.

and we must admit that the chief merit in introducing the method into practice is undoubtedly due to Vanzetti. The same treatment was soon afterwards applied to the carotid artery for the cure of pulsating tumours in the orbit, first by Gioppi,¹ and afterwards by Vanzetti.²

The subsequent experience of surgeons who have employed this method since Vanzetti affords numerous instances of cure, unrivalled for simplicity, painlessness, ease, and rapidity in the records of the treatment of aneurism by any other means. In nineteen cases successfully treated by digital pressure, the average number of hours of pressure was not more than forty-one and a half—spread, however, over a variable period of time, owing to intermissions of the pressure. In a case which came under my own notice in 1868, the patient, a policeman, had had a popliteal aneurism cured in Guy's Hospital, under Mr. Bryant's care³ by digital compression in about twenty-four hours. He returned to his duty, and in about a year afterwards a second aneurism formed in the opposite ham. Of the nature of this tumour there could be no doubt, since it was verified by his usual medical attendant, who had previously placed him under Mr. Bryant's care. The man went to bed and imitated so successfully with his own thumb and fingers the treatment he had seen pursued in the hospital, that he suppressed the pulsation in the sac completely and finally in four and a half hours. When I saw him there was no trace of the tumour beyond a little thickening in its old situation. The man afterwards died of aneurism of the aorta, and the cured popliteal aneurisms are preserved in Guy's Hospital Museum. Mr. Bryant informs me that he has since met with another case in which the patient had cured himself in the same manner.

Digital pressure ought to be effected, when possible, by the united efforts of a staff of trained assistants (in hospital practice, usually medical students), who should make pressure in pairs each for about ten minutes, relieving each other alternately. The one who is not compressing should see that the other holds the artery firmly, and commands the circulation through the tumour completely during the whole period. The hands of the assistants can often be much spared their labour, so that they can carry on the compression for a longer period without changing, and more equably, if a weight is so arranged as to press on the compressing fingers. The point of pressure should be varied whenever that is possible, and great care should be taken to impress upon the assistants, especially if they are entirely ignorant of medicine, the proper direction of the pressure by which the artery can be held with the least force, and the great importance of not using more pressure than is absolutely necessary. A reasonable time must be allowed for sleep, at least in most cases, undisturbed by pressure. When pressure is successful it does not always produce complete consolidation at once. As in the case of acute flexion, the clot is at first soft, and some amount of pulsation often continues for some hours or even days. But the surgeon may be pretty confident that cure is at hand if the pulsation is greatly diminished, and the bruit almost or quite suspended, and more especially if the size of the tumour is seen to be diminishing. Some patients can tolerate the constant application of the compression for a day or two. It should not be forgotten that digital pressure is by no means always painless, but on the contrary sometimes more painful than instrumental compression. In such cases it should be given up, and the latter method substituted, or the artery tied.

The cures, however, which are effected by digital pressure are often very rapid and attended with less pain than any of the other methods; and this kind of compression can occasionally be applied to arteries, such as the carotid, where mechanical pressure is hardly practicable.

TREATMENT BY FLEXION.

The simple bandaging of the limb in acute flexion, the patient being kept at rest, may occasionally succeed in curing aneurisms situated at the bend of the limb, as in the popliteal space or the elbow, and possibly in the groin. This plan of cure had

¹ *Annales d'Oculistique*, 1857.

² *Secondo caso di Aneurisma dell' Arteria ottalmica guarito colla compressione digitale della carotide*, &c., del Dott. T. Vanzetti, &c. &c. Padova. 1858.

³ *Guy's Hospital Reports*, series iii. vol. xiv. p. 241. A case of traumatic aneurism of the femoral artery, under M. Chassaignac's care, cured in seven hours by digital compression, is related in *L'Union méd.* Dec. 2. 1862. Here, however, the compression was continued as a precaution more or less during the next twenty-four hours.

been previously tried ; but the merit of first demonstrating its success is fairly due to Mr. Ernest Hart.¹ All that is requisite in this treatment is to bandage the limb from the toes nearly to the knee with a roller, and then to turn the roller round the thigh flexed at an acute angle ; the limb should then be bent upon the pelvis, and the knee rested against a pillow.

In Mr. Hart's case, the cure had made considerable advance after the first day of the treatment, and was complete on the fourth day ; on the seventh the patient was moving about. In Mr. Shaw's case, the cure was much more protracted, and the cessation of pulsation was not reported till the thirty-eighth day, but then the tumour was larger. In neither of these cases was any rigorous system of diet enforced, nor did the patient complain of the least inconvenience in either. In two cases under my own care,² the aneurism, which was small and recent, was cured, without any inconvenience or distress to the patient, in two days. Numerous other successful cases have been put on record. The most interesting and important of these, in which genuflexion succeeded after the failure of the Hunterian operation, and of instrumental compression on the femoral artery, is reported by Mr. Spence in the 'Edinburgh Medical Journal' for November 1859, p. 434. The patient had applied for advice originally in May 1857, on account of an aneurism, which had only been noticed a month, and which increased so rapidly while he was under observation, that the femoral was tied below the origin of the profunda without further delay. There was some apprehension of gangrene after the operation, showing apparently that the circulation was re-established only slowly. The ligature separated on the twenty-ninth day, and then some undulatory pulsation was noticed in the tumour, which, however was much diminished in size. By bandaging the limb, cautious compression of the femoral artery, and direct pressure by a compress of lint over the tumour, this pulsation was reduced to a line corresponding to the course of the artery, and not larger than the popliteal on the other side. The patient was then discharged, and returned to his avocation, that of a coal-carter. In August 1858 he came to the hospital again, as the tumour had suddenly increased within two or three days. It was then found to be as large, and pulsating as violently, as before the artery was tied. Compression was tried, and persisted in for five months, but the tumour increased instead of diminishing. It was then proposed to tie the femoral artery low down, i.e. in Hunter's canal, since the upper part of the superficial femoral appeared obliterated. Previous to this, however, it was thought right to give a trial to the flexion treatment ; and this succeeded so well, that in a week the pulsation had very much diminished, and in a month the aneurism was quite cured, its contents being perfectly solid, and the anastomosing vessels enlarged. The man again returned to his laborious avocation, and was presented to the Medico-Chirurgical Society of Edinburgh four months afterwards ; the cure being quite complete.³

It ought to be noticed here that this man could not at first bear the complete flexion of the limb ; accordingly a slipper, with a piece of bandage sewn to the heel, was fastened on the foot, and the bandage was then attached to a loop connected with a broad band round his pelvis, and this loop was gradually tightened, so as to increase daily the flexion of the leg on the thigh. The confinement to bed appears to have lasted little more than a fortnight. This milder plan of employing flexion may be often found successful when the patient cannot tolerate more rigid confinement.

Many cases are also reported in which flexion has been successfully used in combination with pressure or Esmarch's bandage. In one under the care of Mr. Pemberton,⁴ the amount of pressure used was so slight that no great importance is attached by him to its action. Yet the aneurism, a large one, and pulsating strongly, was cured in less than twelve hours. A somewhat similar case is reported by Mr. A. Pritchard of Bristol, in the 'British Medical Journal,' March 30, 1861.⁵

The failures which have hitherto been recorded appear not beyond what any other method of treatment is exposed to.

¹ For the details of this case, which I had the opportunity of seeing, in consultation with Mr. Hart, before the commencement of the treatment, see *Med.-Chir. Trans.* vol. xlii. p. 205. In the same volume is the report of a similar successful case under the care of Mr. Shaw. The plan is understood to have been tried some time previously on a patient of Sir W. Ferguson at King's College Hospital ; but it seems likely that the trial was not very persistent. The details have been lost ; and the fact was first mentioned after the publication of Mr. Hart's case. Mr. Hart's case occurred in 1858. It seems, however, that the method was successfully used by Dr. Th. Maunoir of Geneva, in 1857. See Richet, in *Dict. de Méd. et Chir. pratique*, vol. ii. p. 339.

² *Brit. Med. Journ.* 1868, vol. i. p. 585. *Ibid.* April 6, 1872.

³ A second case, under Mr. Hart's care, was communicated to the Royal Medical and Chirurgical Society, in which the cure was effected in a few days without even confinement to the recumbent position. (*Proceedings of the Royal Med. and Chir. Soc.* vol. iv. p. 37.)

⁴ *Lancet*, Sept. 3, 1859, p. 232.

⁵ See also a case by Mr. Colles, in the *Dublin Hospital Gazette*, June 15, 1860 ; and one by Dr. Leith Adams, *Med. Times and Gazette*, Jan. 26, 1861.

Thus in Mr. Moore's case, above referred to (p. 60), flexion was tried unsuccessfully; but then the tumour was large, and was growing rapidly towards the joint; and such cases are peculiarly intractable. In a case under Sir J. Paget's care,¹ this method was tried and failed; but in that case other methods of treatment also failed, the case not being one of aneurism in the proper sense of the term, but of ulcerated artery without a sac.

A case was in St. George's Hospital in 1867 of popliteal aneurism of two months' duration, in a man aged twenty-six, of dissipated habits. Flexion to about a right angle, nearly but not quite stopped the pulsation. After eleven days of flexion the pulsation had ceased entirely. It recurred, however, though to a very slight extent, from time to time, and the limb continued to increase in size, until a portion of the swelling suppurated; and then bleeding occurred from the tumour, necessitating amputation. On examining the limb the artery was found completely divided into two parts. No mention is made of any obvious disease in the coats of the artery. A somewhat similar case under Sir J. Fayrer's care was referred to in my lectures on Aneurism at the Royal College of Surgeons.

M. Liégeois² gives an analysis of forty-nine cases of popliteal aneurism treated by flexion, founded on a thesis by M. Stopin. Twenty-six were cured, flexion being used alone in eleven cases, and in four after other methods had failed. In the remaining eleven flexion was used in combination with other measures. Out of the twenty-three cases which failed, seven are stated to have suffered rupture, and one inflammation of the sac.

The cases best adapted for the trial of flexion are the simplest. In those cases where the tumour is not of very large size, where the parts covering it are not much inflamed, nor the joint involved and where, as far as can be ascertained, the tumour is seated on the superficial face of the artery, we may anticipate benefit from flexion. If the flexion of the limb entirely, or almost entirely, suspends the pulsation and the bruit, this treatment may be trusted by itself; otherwise a compressor must be applied to the artery above, in aid of the flexion. But the compression need not, in such a case, be applied with nearly the same severity which would be demanded in an ordinary case.³ A very slight amount of pressure will often serve; and if the only advantage of this simple and nearly painless proceeding were to spare the patient the annoyance of severe pressure, it would be no slight one. There are, however, many cases in which the aneurism will be entirely cured by it, without the smallest risk either to life or limb.

TREATMENT BY MANIPULATION.

A method of treatment has been founded on the consideration of the pathological changes which by the deposition of fibrine and occlusion of the cavity of an aneurismal sac lead to its cure, and on the analysis of certain cases in which the accidental displacement of clot from within the sac, and its impaction in the artery on the distal side of the aneurism, has seemed to give rise to exceptional cures. Sir W. Fergusson has endeavoured artificially to imitate this process by means of a particular manipulation of an aneurism, whereby the fibrine within may be so displaced as, either in part or in whole, to block up the main artery on the distal side of the disease.

In a paper, which will be found in the 'Medico-Chirurgical Transactions,' vol. xl. p. 1, that surgeon describes two cases which he submitted to this treatment. Both were cases of sub-clavian aneurism. The first patient was a healthy-looking man of middle age, having a large aneurism of two years' standing, involving chiefly the middle part of the artery. In the event of any operation by ligature having been determined on, the vessel must have been tied either on the tracheal side of the scaleni, according to the Hunterian method, or on the distal side, according to the method of Wardrop or Brasdor. Sir W. Fergusson thus describes his proceeding: 'The patient was seated in a chair: and I placed the flat end of the thumb on the aneurismal tumour, so as to cover the prominence. I then pressed, until all the fluid blood had passed from the sac, and I could feel that the upper side of the aneurism was pressed against the lower. I now gave a rubbing motion to the thumb, and felt a friction of surfaces within the flattened mass. The movements were little more than momentary, but they were such as I had preconceived.' The immediate effect was to produce giddiness and mental confusion, so that the patient was for a time unable to stand. Pulsation ceased in the

¹ *Med. Times and Gazette*, 1859, vol. ii. p. 505.

² *L'Union méd.* August 14, 1869, p. 236.

³ See Mr. Pemberton's case, above referred to.

arteries below the tumour, and pain was experienced in the hand and forearm. In the evening, however, pulsation had returned in these vessels. Next day the manipulation in the way described was repeated, with much the same immediate effects. Pulsation returned slowly after some days in the arm and hand. The tumour was thought to have become manifestly less in size, and to pulsate less strongly. It never ceased, however, to pulsate, and eight months after, the patient died, owing to rupture of the sac at the lower and back part. It was found to contain solid fibrine of old date, and recently coagulated blood. The axillary artery was filled with a firm plug of fibrine. In the second case so treated by Sir W. Fergusson, paralysis of the left side of the face, and of the left forearm and leg, followed the manipulation, the pulse ceasing at the wrist. With this exception there was little material change. At the end of two months the patient resumed his occupation as a seaman, having regained the use of his left side; but the tumour being apparently unaltered. A year after he was again seen, and an attempt made to keep up continued pressure on the tumour; but it proved so unsatisfactory, that it was given up. Again, at the end of the year, that is two years after the first employment of manipulation, he returned; and now the tumour had completely disappeared, there was not a trace of it to be perceived; a slight pulse could be felt at the wrist. The arm seemed much the same as its fellow, and the paralysis of the left side had gone off.

Neither of these cases afforded satisfactory evidence of the efficacy or safety of this mode of treatment. In the first case, although the tumour was considered to be somewhat solidified, it never ceased to pulsate; and after a few months caused the death of the patient by bursting. In the second case no perceptible effect was produced on the tumour at the time, nor did it seem to be much changed at the end of a year; but after two years of laborious occupation, the tumour was found to have disappeared. It must be considered doubtful how far this result was due to spontaneous changes, or to accidental displacement of the contents of the tumour in the course of the patient's frequent exertions.

The sudden faintness of both these patients immediately after the manipulation of the tumours, and the paralysis which followed in the second case, indicated sources of danger connected with this treatment, which Sir W. Fergusson did not omit to point out. It seemed possible that in the manipulation some of the broken-down fibrine was squeezed towards the mouth of the vertebral or carotid arteries, and by obstructing the flow of blood to the brain produced hemiplegia in the manner suggested by Dr. Kirkes, who, in a paper read before the Medical and Chirurgical Society in May 1852, pointed out the probability of this condition being produced by fibrine from the valves of the aorta being carried along mechanically in the blood. A case highly illustrative of this danger has since been described by Prof. Esmarch.¹

Captain C. H. consulted a friend of Prof. Esmarch's for tonsillitis, and at the same time drew his attention to a tumour on the left side of his neck, which had formed suddenly three years previously, without appreciable cause, and had now attained the size of a hen's egg. It was easily diagnosed as an aneurism of the common carotid. On repeating the examination a few days later, and exerting pressure upon the tumour for the purpose of reducing it, the patient fell suddenly back with symptoms of apoplexy; he was at once bled, and conveyed to the hospital, where he was placed under the care of Dr. Esmarch. There was right-sided cerebral paralysis; the pupils were dilated, but reacted to the light; the tumour pulsated simultaneously with the carotids, but presented no murmur. Prof. Esmarch diagnosed the detachment of fibrine from the aneurismal sac and consequent obliteration of the left carotid. Death ensued three days afterwards. At the autopsy, performed by Prof. Weber, of which the most careful details are given, the sac of the large aneurism was found to be partly lined with more or less firmly attached, ragged, fibrinous coagula; much loose fibrine irregularly interwoven was also in the sac; a firm coagulum was drawn out of the internal carotid, and this coagulum was found to extend up to the carotid foramen. There was no coagulum in the external carotid. The cerebral carotid, the middle cerebral, and the ophthalmic artery were completely blocked up with coagula of a dark-brown colour, enclosing numerous red and greyish-white plugs, which evidently were derived from the aneurism. Their identity was proved by the microscope. There was considerable softening of the middle of the left hemisphere, including the corpus callosum.

A somewhat similar accident was described by Mr. Teale of Leeds, in some clinical remarks delivered in 1859.² He mentions that in the year 1847 he was one of a numerous consultation in a doubtful case of carotid aneurism. The subject of it was a middle-aged female, in good

¹ Virchow, *Archiv für Path. Anat. und Physiologie*, vol. xi. p. 410, 1857.

² *Med. Times and Gaz.* March 1859, p. 265.

health in other respects. She was seated in a chair while the tumour was examined by several persons in succession, and subjected by them to repeated handling and compression. While this was going on, she suddenly became pale and slipped off the chair. On being raised, she was found to be hemiplegic; after lingering in this state a few weeks, she died. The tumour was found after death to be aneurismal.

These two cases serve to show very strongly the dangers which, as Sir W. Fergusson himself pointed out, are likely to follow the manipulation of aneurismal tumours of the neck. On the other hand, subclavian aneurisms are almost always ultimately fatal, and have never yet been successfully treated by the Hunterian ligature.

Soon after the publication of Sir. W. Fergusson's paper, Mr. Robert Little¹ admitted into the Donegal Infirmary an Albino, aged fifty-three, having an aneurism of the right subclavian artery, of nine months' duration, of considerable size, pulsating strongly, having a loud bruit, soft and compressible, somewhat red and inflamed on the cutaneous surface. Anodynes, sedatives, local refrigerants, and venesection were employed without effect. On January 1, 1856, by making gentle but steady pressure with the thumbs alternately over the aneurismal sac, Mr. Little succeeded in displacing some of the coagula, and directing them towards the distal opening of the artery. No other local treatment was adopted; but the patient was ordered a preparation of iron internally. For the first two days no change was perceptible either in the tumour or the arm; but on the third day the pulse at the wrist was manifestly weaker, and the arm somewhat colder than the opposite one. The symptoms gradually increased up to the tenth day after the manipulation of the sac, when no pulsation could be felt in either the radial, brachial, or axillary arteries. From this time the tumour itself gradually became more solid, and finally all pulsation ceased. The tumour wasted to the size of a small walnut, and two superficial arterial branches could be traced running transversely across it; one immediately above the clavicle, the other somewhat higher up. For a time the arm was partially paralysed and very cold, but it subsequently recovered sensation and motion; and when the patient was seen a year afterwards, his cure was in all respects complete.

In addition to this highly satisfactory and interesting cure, Mr. Teale of Leeds, and Dr. G. E. Blackman of Cincinnati, have each successfully treated an aneurism of the lower extremity by manipulation, aided, however, in each case by compression. Dr. Blackman's case is not very convincing. In Mr. Teale's the second manipulation of the sac was followed by the immediate cessation of the pulsation, which had been increasing up to that time in spite of compression, and a prior attempt at manipulation.²

In a lecture on this subject, delivered at the Royal College of Surgeons,³ I arrived at the following conclusions with respect to the results of the manipulation-treatment, and have no subsequent experience to produce. It had been used in five cases of subclavian and two of femoral aneurism. There was no proof of rupture of the sac in any of the cases, though in one it was suspected. There was clear evidence of a cure in two cases and a good advance towards cure in another. From this I inferred that the treatment was justifiable in suitable cases, viz. where there was some evidence of deposit of fibrine in the sac, where the aneurism was not of large size and its distal extremity easily accessible to the touch: it being of course premised that the disease is not amenable to less dangerous and more promising treatment.

ESMARCH'S BANDAGE.

A very useful addition to our means of treating aneurism was introduced into practice by Staff Surgeon Reid of the Royal Naval Hospital, Plymouth,⁴ viz. the application of Esmarch's bandage. This seems to combine direct pressure with the total stoppage of the circulation, and thus to unite, at least during the time of its application, the advantages of direct and indirect compression, and possibly also of manipulation, for it is very likely that the clot in the sac may be somewhat displaced, and thus give rise to further coagulation in the sac and obstruct the opening into the artery. Esmarch's bandage appears, as far as present experience enables us to judge, to be rather an adjunct to the method of compression than an independent

¹ *Med. Times and Gaz.* May 23, 1857.

² Blackman, *Western Lancet*, June 1859. *New York Journ. of Med. Sci.* 1857, p. 291. Teale, *Med. Times and Gaz.* p. 265, March 1859.

³ *Lancet*, vol. i. 1873, p. 159.

⁴ *Lancet*, Sept. 25, 1875. *A New Method of Treating External Aneurism*. London, 1876. See also *Transactions of the Surgical Section of the International Medical Congress*, 1881, p. 5.

means of cure, for though possibly cases may have been cured solely by this means, they are exceptional; and in all the successful cases on record, as far as I can ascertain, the surgeon has thought it prudent, if not necessary, to use digital or instrumental pressure as a precautionary measure after the removal of the bandage. This was done in Dr. Reid's original case, which was as rapidly and completely successful as any of those since recorded. In that case also, as in most of the others, digital and instrumental compression had previously been employed, and, as he points out, may have contributed to the cure. But, however this may be, there is no doubt of the high value of this method of treatment; and it is one which should not be neglected in any case where there seems no contra-indication to direct pressure. Such contra-indication would be found in any circumstance that would seem to augur a probability of the sac bursting.¹ But, as it seems to me, the use of Esmarch's bandage is above all indicated in small aneurisms approaching the tubular variety, and therefore devoid of any distinct bruit. Such a case was under my own care, unfortunately just before I had heard of Dr. Reid's case, and after the failure of other means I was obliged to tie the artery.² In such a case as this I should expect Esmarch's bandage to succeed rapidly and almost certainly, while in a large and rapidly increasing or an inflamed aneurism I should think its employment rather prejudicial to the patient's chance of surviving, and should recommend immediate ligature.

The method of applying the bandage is very clearly described by Dr. Reid, and I am not aware that any improvement has since been made. The pressure over the sac should be slight, or perhaps the sac may be avoided altogether, 'bandaging as lightly as possible over the tumour, or even shifting it by one or two adroit turns of the roller, and leaving its surface free' (Reid). Mr. Heath³ even proposes to endeavour to keep the sac artificially distended by carrying the upper part of the roller from above downwards, so as to drive the blood in the thigh towards the sac, the surface of which is left uncovered. This, however, appears unnecessary, and may possibly be prejudicial as rendering the obstruction of the mouth of the aneurism less probable. As to the precise time during which the pressure may be applied, we have at present no certain means of laying down an exact limit. It seems best to commence with an hour's pressure of the bandage, keeping the patient under the influence of ether or chloroform, if necessary, and to be guided as to the time and duration of a second trial by the results of the first. There seems no serious danger in an application protracted to two hours in an ordinary case. When the cord is removed, digital or instrumental pressure is to be kept on the femoral artery for a few hours.

Dr. Stimson of New York⁴ has collected sixty-two cases in which Esmarch's bandage has been used for popliteal aneurism, but in only fifty-two of them has Dr. Reid's method been followed. Of these twenty-eight were successful, twenty-two failed, and two died, in one with commencing in the other with impending gangrene. Mr. Pearce Gould's table in the 'Transactions of the International Medical Congress' shows out of forty-seven popliteal aneurisms thus treated, either twenty-seven or twenty-eight

¹ Mr. O. Pemberton says with much truth, in discussing Dr. Reid's paper above referred to, that 'this method of treatment cannot be advisable in large aneurisms, or where there is any serious venous obstruction.'

² *Clin. Trans.* vol. ix. p. 19. Dr. Reid is of an opposite opinion, and thinks that his method is not well adapted for tubular aneurisms; but it seems to me that Dr. Reid lays too little stress on the impaction of the clot in the artery as it enters and leaves the sac which post-mortem examination shows to be produced by Esmarch's bandage. If its use were to be restricted to purely sacculated aneurisms, it would be restricted indeed, if by that term be intended aneurisms which stand out like a bud off the artery and have only one opening of communication with it. Most aneurisms (as I think I have proved) approach nearer to the tubular form, and have two openings into the artery. Impaction of clot in the proximal opening or in both is a potent means of cure, and this seems often effected by direct pressure. Stagnation of blood in the aneurism seems to me of inferior importance, since if the mouth of the aneurism is unobstructed, the soft clot so formed must be redissolved. For evidences of this impaction of clot after the use of Esmarch's bandage I would refer to Mr. Wagstaffe's case, described and figured by him in 'Path. Trans.' vol. xxix., and to the post-mortem examination of Dr. Reid's case, which, however, is less convincing, since a longer time had elapsed.

³ *Clin. Trans.* xiii. 155.

⁴ *Am. Journ. Med. Sci.* April 1881.

in which a cure is claimed, and eight cases of femoral aneurism, in five of which the method was successful; but, as Mr. Gould very truly says, the method has so often been used, and generally unsuccessfully, in cases which have not been published, that no conclusion can be drawn from such figures. Present experience does not enable us to give any positive estimate of the danger of the attempt, when it fails. That so severe a proceeding, if it fails to cure the aneurism, must render the case more dangerous, is, I should have thought, almost self-evident. The mere production in the sac of a certain amount of soft clot¹ is a transitory and doubtful benefit which the great disturbance of the circulation of the limb, the pain and constitutional irritation, far more than counterbalance. I would, therefore, restrict this method of treatment to those cases in which a cure may reasonably be hoped for in one sitting, that is to recent and small tumours; and as the use of digital pressure with or without genuflexion involves no such risks and very little inconvenience, it appears to me to be unjustifiable to use the bandage except on the failure of these milder and safer measures.

The dangers are: 1. From rupture (partial or complete) of the tissues forming the sac. 2. From gangrene produced either by the suspension of the entire circulation of the limb, or by the sudden obstruction of the aneurismal tumour, or possibly by the simultaneous pressure on the vein; and 3. Possibly, as Mr. Gould believes, from increase in the blood pressure in the heart and large vessels resulting from the expulsion of the blood from the limb. This idea seems to be founded on the fatal result which followed in a case² where the patient had phthisis and fatty heart, and the bandage was twice applied, and each time over two hours. The case does not seem to me to support the conclusion, but I should not myself venture on the application of the bandage in any such case, believing that the ligature, though no doubt very dangerous, would be on the whole the best. The sugillations of blood which are sometimes found in the neighbourhood of the sac prove the severity of the effect on the tissues forming the sac. They will be found described by Mr. Bryant in his observations on Dr. Reid's and Mr. Gould's papers; where will also be found an account by Mr. O. Pemberton of a case under his own care which proved fatal from gangrene.

It does not seem that the use of Esmarch's bandage exercises much deleterious influence on the prospects of subsequent ligature, should this be found necessary. In twenty of Mr. Gould's cases the artery was subsequently tied; seventeen recovered completely, and another after gangrene of the foot; and two died, one after amputation, and the other from pyæmia.

TREATMENT BY COAGULATING INJECTIONS.

The treatment of aneurism by the injection of a coagulating fluid into the centre of the tumour is so uncertain and so little used that a short account of it must suffice. The first proposal was put forward by Monteggia,³ who suggested alcohol, acetate of lead, and tannin as coagulating agents. Wardrop⁴ suggested acetic acid, advising also compression so as to stop the circulation above and below the tumour. But since the experiments of Pravaz on the effects of perchloride of iron, that substance has been chiefly, if not solely used. Upwards of thirty cases so treated have been collected; and there can be no doubt of the possibility of thus coagulating a large portion at any rate of the blood in an aneurism. But this cannot be done without great danger. The dangers proceed either from inflammation and abscess, set up in the neighbourhood of the sac, from inflammation of the sac itself, producing gangrene, or rupture of the aneurism, or from the consequences of embolism. In

¹ Dr. Stimson's article contains a description of the condition of the parts after death in two cases, and a drawing of the dissection of an aneurism cured by Esmarch's bandage (from 'Path. Trans.' xxix. 72). They show soft coagulum which in the latter case was hardening (but without lamination), and obstruction of the artery in the neighbourhood of the tumour.

² Dr. R. F. Weir. *Arch. of Med.* xxxi. 210. No. 29 in Mr. Gould's table.

³ *Istituzioni Chirurgiche*, pp. 68, 82, 124. Milan, 1813.

⁴ Costello's *Cycl. of Prac. Surg.* i. 218.

eighteen collected cases, the injection proved fatal four times; twice from gangrene of the limb, once from hæmorrhage following gangrene of the sac, and once from phlebitis. This is a formidable roll of accidents and a large proportion of deaths. It will seem yet larger, when we remember that it is a condition of primary necessity, now recognised by all surgeons, that before the method of injection can be applied, it must be possible to arrest the current of the blood by pressure on the artery above and below the tumour. Thus it would be possible in nearly all these cases to apply either instrumental or digital compression or flexion; proceedings which can count a larger proportion of successes, and which are not open to the same objections.

The treatment by injection has been applied to nearly every form of external aneurism: to popliteal aneurism, by Niepce, Lenoir, Minor, and Isaacs; to carotid aneurism, by M. Dufour; to aneurisms of the elbow, by M. Jobert, Serres d'Alais, Vallette, and Dieulafoy; and even to aneurisms of the innominate, by M. Barrier; of the subclavian by Pétrequin; and of the aorta by Syme. The last three varieties are totally out of the domain of this method of treatment, because they are inaccessible to the compression of the artery on their cardiac and distal side; and without this precaution, the small clots formed by each drop of the perchloride on its entering the sac, are likely, as has been proved by experience, to be carried by the blood into the ramifications of the artery and produce gangrene. To repeat those experiments would therefore now be unjustifiable. Aneurisms of the popliteal artery, and of the extremities generally, are susceptible of such satisfactory treatment by compression and flexion, that the more dangerous method of injection would here be out of place. An exception, however, must be made for those varicose aneurisms seen most commonly at the elbow after venesection, which have not always proved amenable even to digital compression, and in which deligation is somewhat complicated and difficult. Injection of perchloride of iron has four times been successfully applied to such a condition by Jobert, Serres, Vallette, and Dieulafoy; and proper precautions being used, this method may here be found advantageous. The same may also be said for cirroid and anastomotic aneurism. (See 'Cirroid Aneurism'.)

When in any case it is determined to inject a coagulating fluid, it is desirable to adopt certain precautions. In the first place, as to the fluid selected. Various preparations of iron, such as the lactate, the persulphate, the acetate of the sesquioxide of iron, tannic acid, alcohol, and acetic acid, have been recommended and employed; but the coagulating power of the solution of the perchloride is so much greater than that of any of these fluids, that it obtains the preference notwithstanding its irritating qualities. In order to reduce this irritating action to its minimum, it is desirable to employ a neutral solution of the perchloride and one of feeble dilution. Very careful directions have been given for the preparation of the solutions by M. Burin-Dubuisson,¹ M. Soubeiran,² and others. In the earliest cases a solution was employed of the strength of 45°—49° Beaumé, *i.e.* sp. gr. 1.454—1.526; but experience has shown that solutions of this strength are productive of excessive inflammation, and lead almost inevitably to grave accidents. The experience of M. Valette has shown that a solution of twenty degrees possesses great coagulating power, and no higher degree of strength should be employed. Care also should be taken not to inject an excess of the perchloride; for this not only inflames the tissues of the sac, but diminishes the solidity of the clot. M. Broca advises the injection of twenty drops to every centilitre (100th of a pint) of the contents of the aneurismal sac. The recent experience of M. Dieulafoy (1859) seems to show that one-tenth of this quantity may suffice; and that for an aneurism containing twelve centilitres, or three and a half ounces, eighteen to twenty drops only need to be injected. The best instrument for the purpose is the small graduated syringe with screw piston and glass body, made for the purpose by most instrument-makers, and

¹ *Compte rendu de l'Acad. des Sciences*, Jan. 16, 1854, vol. xxxviii. p. 89.

² *Bulletin de Thérapeutique*, vol. xlv. p. 454, 1853; see also *Thèse de M. Jean Pravaz*, Paris, 1857.

also used for subcutaneous injections. In performing the injection, it is necessary first to establish accurate compression of the artery above and below the tumour, so as completely to arrest the blood in it. The pointed trocar is plunged perpendicularly into the tumour, care being taken on the one hand not to miss the cavity, and on the other not to transfix it, both of which accidents have happened to experienced operators. The success of the step is indicated by the issue of *arterial* blood, an indication which should be looked for. The cannula is now screwed on to the trocar, and so much as may be thought necessary of the injection is pushed out into the fluid contents of the sac by successive turns of the piston. Each turn is usually equivalent to half a drop, and the quantity injected may be further estimated by a reference to a scale, which should be marked on the glass body of the syringe. The point of the trocar may be directed upwards, downwards, and on either side, without withdrawing it, so as to form several centres of coagulation. When the tumour has acquired a certain consistence and the coagulation has sufficiently taken place, one turn backwards should be given to the piston, so as to draw up the liquid contained in the cannula and to prevent its irritating contact with the tissues; it is then carefully withdrawn. The compression of the artery on the cardiac side of the sac should be continued for an hour.

It is necessary to attend to these precautions very carefully, because experience has shown that owing to their neglect many of those serious accidents occurred which marred the success of the earlier cases. Notwithstanding their observance, it is to be expected that inflammation of the sac, with its attending disasters, will frequently follow the injection of the perchloride of iron; and since this method is mainly applicable to those superficial aneurisms which can be treated by other proceedings not open to that objection, and not followed by those dangers, the applications of the treatment by injection are likely to be limited.¹ The discovery of a fluid of great coagulating power, and devoid of irritating properties, is a desideratum in this method.

INTRODUCTION OF FOREIGN BODIES INTO THE SAC.

Mr. Moore suggested a method of inducing coagulation in the sac of an aneurism by means of the introduction of a large quantity of fine iron wire. The object of this proceeding is to detain the fibrine of the circulating blood, and thus to form a clot, much in the same way as in the common experiment of whipping the fibrine out of a mass of blood with twigs.

The reader may refer to Mr. Moore's case, which was one of aneurism of the aorta ('*Med. Chir. Trans.*' vol. xlvii.) for the history of this attempt. It proved fatal from inflammation of the sac and parts around. Doubtless the substance used was too irritating; and the use of wire is now abandoned. Still the preparation from Mr. Moore's case, in the Middlesex Hospital Museum, shows that a good deal of coagulum was really formed about the wire, and of late the attempt has been renewed, using carbolised catgut, or horse hair, instead of wire. Horse-hair is no doubt by far the best material on account of its combining softness and firmness with insolubility; and Mr. Bryant's case² seems to me to show the possibility of producing complete consolidation in this manner. Yet the method must always be one of very limited application. It ought not to be used when there is any reasonable chance of success by ligature or any form of pressure, and its superiority to galvano-puncture is very

¹ In Gurlt and Hirsch's *Jahresbericht*, vol. ii. p. 314, Berlin 1869, will be found a reference to a work by Signor Marsacci on this method of treating aneurism; in which the author relates numerous experiments with all known kinds of coagulating fluids. The conclusion arrived at is that expressed in the text, viz. that the method is one not deserving of confidence, and which it is unjustifiable to employ in cases where compression can be used. Dr. Stimson, in the American reprint of the second edition of this work, has referred to two cases under Dr. Hutchinson's and one under Dr. Eliot's care, in all of which the method was either useless or injurious.

² *Practice of Surgery*, vol. i. p. 435. Some other cases are cited by Stimson in the reprint of this essay above quoted.

doubtful. But perhaps in some cases of subclavian or aortic aneurism its employment may be justifiable.

Other surgeons have also tried to induce coagulation by introducing foreign bodies temporarily into the aneurismal sac. The operation has always been performed by means of needles, which have been withdrawn when the coagulation has seemed sufficiently far advanced. M. Richet mentions¹ five cases in which this plan has been adopted, but in no case with any success, and in some with very grave accidents. Mr. Heath, in recording a case of subclavian aneurism in which he tried the introduction of three pairs of needles into the sac, says that Mr. Marshall has in this way on more than one occasion produced temporary clotting to a considerable extent in an aortic aneurism. In Mr. Heath's case the needles were left for five days in the sac. The case proved fatal, and after death a good deal of coagulum was found round the needles.² I should myself be inclined to try this plan before filling the sac with horse-hair. In another case cited by M. Richet a very small temporal aneurism was treated by inserting two needles and tying a ligature beneath them, as for nævus, and with success. This, however, is quite a different matter. M. Velpeau and Mr. B. Phillips are also referred to by Mr. Moore as having performed experiments to prove that aneurism might be treated in this manner. But I do not find that either ever used acupuncture on the living body, except in combination with galvanism.

TREATMENT BY GALVANO-PUNCTURE.

In the preceding modes of treatment of aneurism it is proposed to effect a cure either by retarding the course of the blood, or by introducing elements which favour the precipitation of its plastic principle. Galvano-puncture aims at producing such a modification of the contents of the sac as shall favour slow coagulation, without incurring the risk of introducing into the circulation foreign and perhaps injurious matters. This end it occasionally accomplishes; but it is not without its own peculiar accidents and dangers. Indeed, the first applications of electro-puncture made by Benjamin Phillips,³ Liston, and Gérard, in 1838, and the subsequent essays of Mr. Keate,⁴ were so little successful as to discourage further trials; and but for M. Pétrequin,⁵ whose persevering application of this plan was, in 1845, followed by success, the procedure might not yet have found a place in practical surgery. Since the publication of those cases, repeated applications of this method have been made to all kinds of aneurism. But, although these have served to show clearly the power of electricity to effect the cure of aneurisms, they have shown also very clearly its danger and the accidents to which it may give rise. It is a radical defect of this procedure that it acts by inducing direct (or 'passive') coagulation of the blood in the sac. Hence it is inherently uncertain, liable to cause relapse by the melting of the coagulum, or inflammation by its too sudden deposition. Again, it is very liable to set up inflammation in the walls and contents of the sac. Then, too, the needles sometimes produce eschars at the points of their insertion, and thus give rise to consecutive hæmorrhage. In fact, the cases are few in which a perfectly happy result has been obtained; but some of these are worthy of particular attention.

Thus a subclavian aneurism, forming a tumour as large as a hen's egg beyond the clavicle, was cured by this method by Dr. Abeille.⁶ The success of this case alone, the size of the

¹ Richet, *op. cit.* p. 324.

² *Med.-Chir. Trans.* lxxiii. 65. In the *Lancet*, Oct. 13, 1877, is the report of a case of multiple aneurism under Dr. MacEwen's care in which the cure was attributed to the temporary introduction of a steel needle into the sac while the artery was commanded by instrumental pressure. The needle was kept in for an hour, its direction being shifted from time to time.

³ *Experiments showing that Arteries may be obliterated without Ligature.* See the work of Phillips, London, 1832; and his Letter claiming priority of invention, in the *Archives gén. de Méd.* 1847.

⁴ *Lancet*, 1837-8, vol. ii. p. 668.

⁵ *Compte rendu de l'Acad. des Sciences*, 1845, vol. xxi.

⁶ *Archives gén. de Méd.* Aug. 1849.

vessel affected, its proximity to the heart, the rapid increase of the tumour, and the coincidence of constitutional disease, would suffice to give importance to the method by which it was cured. Again, the successful application of galvano-puncture by Nélaton to cirroid aneurism,¹ and to varicose aneurism at the elbow by Voillemier, afford instances of success in the treatment of varieties of the disease not very amenable to other modes of treatment. Many cases are recorded in which galvano-puncture has been employed with some success in the treatment of aneurism of the ascending aorta; in some with the result of producing what is described as 'a very sensible and evident improvement,' while in others the improvement was so great that the patient appeared at any rate temporarily cured.

One of these latter cases is so striking, and so well illustrates the method, that a short abstract of it will be offered. It is reported by Signor Ciniselli, in the 'Gaz. des Hôp.,' Nov. 17, 1868. The aneurism was of the ascending aorta on the right side, and was rapidly increasing; the third and fourth ribs, and the intercostal space between them, were much pushed outwards by the tumour; its pulsations were powerful, and very perceptible to the eye as well as to the touch. The patient could not lie on his back, was much troubled by loss of sleep, and quite unable to follow his occupation. At the same time the absence of alteration of the voice, and of obstruction to the jugular veins, with the limited extent over which pulsation could be felt, rendered it probable that the aneurism was not of any large size. Three polished steel needles were buried in the tumour, each penetrating the sac of the aneurism to about an inch in depth. The positive pole of the battery was first applied to each needle in succession, the negative pole being placed in contact with the skin over the tumour. This precaution is said by Ciniselli to prevent the formation of eschars. The electric current was procured from a pile formed of thirty square couples, each side measuring ten centimetres (about three inches), steeped in a solution of sea-salt. The current was directed down two of the needles for ten minutes, the whole proceeding lasting forty minutes. The withdrawal of the needles was followed by a little bleeding, easily checked by saturnine compresses and ice. The same means also reduced the redness and swelling, which was the only sign of local reaction. No general symptoms followed. The tumour rapidly diminished in prominence and in pulsation: the patient could lie on his back, and was able to sleep almost immediately after the operation. The aneurismal bruit, which had been very loud, also gradually disappeared, and it seemed that the tumour had become solidified, though some pulsation could be still felt, which was thought to be that of the aorta transmitted through the solidified mass. He was kept quiet as long as possible; but ten weeks after the operation, feeling himself quite well, he resumed his occupation, that of a coachman.

From the study of numerous collected cases, it may be seen that the *modus operandi* of galvano-puncture in cases where cure has followed its application has not always been identical. In some instances, the introduction of the needles into the sac and the application of the current has apparently been followed by the formation of a clot which only partially filled the aneurismal sac; and by virtue of the power which freshly deposited fibrine has of attracting to itself fresh layers of fibrine from the circulating blood, the clot has gradually increased in size, until the tumour was solidified and cure effected. This is the most favourable sequence, and may be regarded as the typical result. But this sequence is rare. In other cases, at the end of the sitting the sac is already filled with a more or less solid coagulum; sometimes this melts; sometimes it remains permanent and yields a cure. Most commonly, however, the introduction of the needles has been followed by symptoms of inflammation within the sac, and the cure has been due to the effect of this inflammation. Either coagulation has slowly followed upon the inflammatory action, or suppuration and obliteration of the sac has been induced.

The best account that I am acquainted with of the method and the results of galvano-puncture as applied to the cure of thoracic aneurism is to be found in the posthumous work of Ciniselli.² The rules which that eminent authority gives for the use of the method are thus summed up by himself (*op. cit.* p. 206): 1. To use an apparatus of weak intensity, but of sufficient tension to obtain the chemical effect which results in the formation of the electric coagulum.³ 2. To use needles from two to six in number of well-polished steel, thin, but strong enough to penetrate the

¹ See *infr.* Cirroid Aneurism. See also an interesting paper by Dr. Duncan, *Edin. Med. Journ.* April 1866.

² *L'Elettrolisi e le sue applicazioni terapeutiche.* Cremona, 1880.

³ For this purpose, Ciniselli has used Volta's battery, that of Daniell as modified by Barzanò and Dell'Acqua, and others, but prefers one constructed by himself, which is described and figured in his work.

tissues, which sometimes are somewhat resisting. 3. To avoid cauterisation of the tissues by connecting the positive pole with one of the needles while the negative pole is applied to the skin in the neighbourhood by means of a moist conducting medium. This circle is to be kept up for five minutes or a little more till the dark areola is formed around the needle which indicates its isolation from the tissues in its vicinity. Then the same needle is to be put in communication with the negative pole, and the positive pole to be transferred to a second needle, and so on in succession to all the needles, so that no needle is connected with the negative pole till after it has been subjected to the action of the positive, and thus each needle is connected with both poles. 4. So to dispose the conductors as to spare the patient all shocks on changing contact, not to prolong the operation more than from twenty to thirty minutes, and to draw out the needles at once. 5. Not to repeat the operation till all local reaction has ceased, remembering that the coagulum produced by the electro-puncture sometimes requires a considerable time for its completion, so that it is always advisable to wait for a time, until the reaction has ceased and the tumour is of a harder consistence and pulsates less vehemently. Operations so conducted are, according to Ciniselli, usually attended with little suffering, though in a few he employed anaesthesia. The skin over the tumour becomes red, and the tumour itself more tense; a dark areola forms around the needles under the action of the positive pole, the extensive and irregular undulation which the needles exhibit at the beginning of the proceeding becomes limited and regular, and this, together with the alteration in the note of the aneurismal sounds, indicates the formation of the electrical clot, which is also sometimes accompanied by a peculiar sound in the tumour itself, described as 'imitating what in French is called *craquement*, a sound which was not continuous, but occurring from time to time, and with variable duration.' No alarming symptoms followed in any of the cases. The local reaction which usually took place was easily controlled by lead lotions and the application of ice. Slight ulceration around the needle-holes was noticed in only a very few cases, and the ulcers healed without any ill consequence.

In speaking of the results he divides aortic aneurisms into three classes: 1. Endothoracic, of which there were twenty-two. All are said to have derived benefit in the form of diminution or disappearance of neuralgic pain, mitigation of dyspnoea, more regularity of circulation, power of lying on the opposite side to the aneurism, restoration of calmness, sleep, general comfort, strength, and power of taking exercise. The tumour also became more solid and the pulsation less expansive. This amelioration was maintained in more than half the cases for a time varying from one to four years, and was still continuing in two, operated on one four years, the other two years, before the report. In many cases the relapse which occurred was provoked by the patient having abused the powers which he had obtained from the operation, and taken to drinking, to violent exercise, or other imprudent courses. In only three cases, in Signor Ciniselli's judgment, was the improvement only slight and transitory.

2. In fifteen cases the aneurism had made its way externally through the walls of the thorax. In two of these cases no effect seems to have been produced, and in five others there was no benefit from the electro-puncture. In all these seven instances the disease was in a very advanced stage. Even in the remainder, the benefit obtained was but transitory and the disease ran its usual course.

3. In four other cases in which the aneurism had made its way to the surface by projecting into the root of the neck, no benefit was produced in two (both of them very advanced), while in the other two the course of the disease was thought to have been checked—in one for seven, in the other for eleven months.

The conclusion which Signor Ciniselli comes to on the subject is the following: 'It is thus shown that the aneurisms which give the best results are those that are entirely endothoracic, lateral, of small or moderate size, and free from vessels arising out of the sac, or from valvular lesions; that these beneficial effects are still appreciable when the aneurism is partly lateral and partly cylindrical, if the dilatation of the whole artery is not great; that they are merely transitory in the cylindrical form, or in those which are mainly cylindrical, though partly lateral, as well as in those which are complicated by vessels arising out of the sac (which for the most part are

cylindrical dilatations of the arch), or complicated with valvular defects, or those which, though lateral, are of very large size; and that no benefit can be anticipated in those which have increased to such an extent as to erode the bones and project through the thorax' (*op. cit.* p. 324).

I might refer to many other authors who have made trial of galvanism in aortic aneurism, but the above reference is, I think, sufficient. Those who wish to go more thoroughly into the question will find also much instruction in the works of Dr. Althaus and Dr. Duncan of Edinburgh. The former¹ has described a form of battery which is very portable and convenient for the removal of tumours, and the treatment of other forms of disease by electricity. By immersing only the needle connected with the negative pole of this apparatus in the sac, he believes 'a foreign body may be safely deposited in the sac, round which we may expect a slow and gradual deposit of laminated fibrine to take place.'

It seems then from a consideration of the experience of surgeons hitherto that this method of treatment must be restricted to internal aneurisms which are not too advanced, and which are at the same time accessible. In all external aneurisms there are, I think, more promising and less dangerous means at our command, but in aortic aneurisms, when any active treatment is indicated, the choice lies between distal ligation and galvano-puncture, and the latter seems to me in many instances preferable. The distinctions pointed out by Ciniselli as to the form and the complications of the aneurism are very important, if they can be established during life, but it must be confessed that few diagnosticians could form any reliable opinion as to whether a thoracic aneurism is lateral or cylindrical. The character of the bruit and the state of the radial and carotid pulses does, it is true, justify a conjectural—but only conjectural—diagnosis as to this point, and still more as to the origin of branches from the sac. I would refer the reader to the section on 'Brasdor's Operation' for further discussion as to our means of diagnosis in aortic aneurism. Galvano-puncture may also be applied in innominate and in subclavian aneurism, but in all cases it is to be regarded as far as present experience goes as a doubtful expedient, only to be used on the old principle—'*Meliùs est anceps remedium quam nullum.*'

TRAUMATIC ANEURISM.

By 'traumatic aneurism' is meant a tumour containing blood, communicating with the cavity of an artery, and due to a wound of the vessel. Three descriptions of injury may lead to the formation of a traumatic aneurism: 1. A wound penetrating from the surface. 2. A tearing or strain of the coats of the vessel without wound. 3. Fracture of a neighbouring bone.

The first is the most common, or at least the most commonly recognised² cause of traumatic aneurism. A man receives a stab or a small incised wound. It bleeds freely, and most likely in jets; but the hæmorrhage is restrained by firm pressure; the wound heals, and the man thinks himself cured. He is conscious, however, of some loss of power and some anomalous sensations in the limb, such as cold, numbness, tingling, and a feeling of weight; and later on he discovers that a pulsating tumour exists beneath the scar of the wound.

In such a simple case it is easy to see what has happened: the artery has been penetrated by a wound which was too large to be closed by the mere efforts of nature,³ but which did not cut the tube across, and did not stop the circulation.

¹ *On the Electrolytic Treatment of Tumours and other Surgical Diseases*, p. 12. Dr. Althaus differs from Ciniselli, believing that the negative pole only ought to be brought into contact with the blood in the sac. He gives no case of his own, but cites an instance in which an aneurism was thus cured though by mistake, for the operator had intended to apply the positive pole.

² If we consider the frequency with which popliteal and other surgical aneurisms are attributed to accident, and their much more frequent occurrence in persons and in situations most exposed to violence, we might be tempted to conclude that such aneurisms are usually traumatic, and due to the second of the class of causes above enumerated.

³ See vol. i. pp. 364-8.

The blood has not had a very direct exit by the skin-wound, probably in consequence of the altered position which fasciæ and other membranous structures assume in deep wounds, under varying conditions of pressure, tension, &c., and therefore the bleeding has not interfered with the healing of the opening in the skin. Meanwhile, below the fascia blood has continued to exude into the cellular tissue among the muscles, forming a large diffused ecchymosis. Sooner or later, the presence of the blood acts as a source of irritation, and sets up inflammation in its neighbourhood. This causes condensation, and then contraction of the areolar tissue, and so a sac is formed. By this time probably a great part of the blood has coagulated, and so the aneurism (as it now is) contains a mixture of clotted and fluid blood, as most aneurisms do. When traumatic aneurism is fully formed, the case differs in no respect from one of spontaneous aneurism, except, perhaps, in its greater proneness to cure, since the heart and arteries are probably healthy; while in spontaneous aneurism they are often diseased.

The symptoms of traumatic aneurism following an open wound are generally distinct enough. The scar of the wound will be discovered even if the history is obscure, and the pulsation and bruit are generally distinct. But it must not be forgotten that, before the sac has been formed, pulsation is often indistinguishable, though the bruit can almost always be recognised. Such lesions as these are often incorrectly spoken of as 'aneurisms'; a term which is only applicable when the sac has formed. This is not a theoretical or pedantic verbal distinction, but a practical difference of the greatest importance. The formation of a sac is the first step towards the cure of the disease, and shows that the case is amenable to the comparatively mild and indirect measures which are adequate for the cure of an aneurism, such as pressure on the main trunk, or its ligature at a convenient spot above the tumour, instead of requiring the frequently severe and difficult operation necessary for exposing and securing the wounded part of the vessel.

Traumatic aneurisms differ in rapidity and readiness of formation according to the nature of the tissue with which the wound communicates; whether the wound be in a large cavity filled with loose cellular tissue, or a space where the blood will be bound down and disposed in extensive membraniform layers by contiguous fasciæ or tense muscles. Thus, in the axilla or orbit, traumatic aneurisms of large size soon follow on injury to the main artery, or even to a comparatively small branch. The well-known case of Lieutenant Seton ('Med.-Chir. Trans.' xxix. 107) was an example of this fact. A wound of a branch of the external iliac, the patient being stout and the cellular interval large and loose, occasioned an extravasation of blood, which was large enough to lead to the belief that the parent vessel had been injured. In the limbs, on the contrary, the formation of aneurisms in consequence of wounds of large vessels is more rare; and when formed, they will often undergo a process of spontaneous cure by rest and simple measures. The reason for this doubtless is, that before aneurism has formed, the blood itself, bound down by tense fasciæ and strong expanded layers of muscle, exercises pressure on the wounded vessel, tending to limit the effusion and close the wound; and after the tumour has been developed, the pressure which (it must never be forgotten) the sac exerts upon its contents is materially aided by the pressure of the soft parts upon the sac.

The progress of traumatic aneurisms, therefore, is not always towards death, even if left alone; and when they are of small size they are generally easily cured. Direct pressure is peculiarly applicable; but it should be carefully regulated and adjusted, so as to avoid the danger of sloughing. Perhaps digital pressure is the most efficient and safe, if circumstances allow us to secure the services of a relay of attendants, who will make gentle and steady pressure with their hands over the sac. Or in very small aneurisms lying against a bone, the patient may be directed to keep his finger on the pulsating part whenever he can. I have seen a small temporal aneurism, the result of the blow of a stone, thus treated with sufficient success to avoid the necessity of any other treatment. In larger and deeper tumours some form of bandage, with the intervention of an air-pad, may be necessary. Forced flexion of the limb is of course often advisable. With direct pressure may be

combined the compression of the trunk leading to the swelling,¹ and the limb should be raised.

If these means fail, the artery must be tied. Some authors prefer in these cases the method of Anel to that of Hunter, arguing justly, that as the artery will be found healthy close to the tumour, one of the advantages which Hunter's method has over Anel's operation is lost.² This is quite true; but the general advantage of Anel's method over Hunter's, *ceteris paribus*, is very slight, since the mere fact of there being a portion of artery pervious between the ligature and the tumour hardly ever affects the progress of the case. If, therefore, the tumour be deeply seated, and it would be difficult to expose the vessel, as it leads into it, no hesitation need be entertained in trusting to the Hunterian method; while if (as is usually the case at the bend of the elbow) the tumour and the artery on which it is seated be superficial, the whole operation of opening the sac and tying both ends of the vessel offers no special difficulties, and is more certain to succeed. It is therefore often adopted; and we shall see, when treating of axillary aneurism, that it has been recommended by a high authority for general use in that form of the disease. Still, the great majority of traumatic aneurisms have yielded to the proper application of pressure, and few of those which have not done so are known to have resisted the Hunterian operation. It is only in cases in which the tumour is superficially seated, and the operation therefore comparatively easy and bloodless, that the majority of surgeons would prefer the old operation.

Traumatic aneurisms from contusion or sprain, without external wound, are too closely allied to those of spontaneous origin to call for any special notice in this place.

Notwithstanding the remarkable immunity which arteries enjoy even in the most formidable injuries, it is not surprising that, as they lie so close to the bones in many situations, they should occasionally be wounded by splinters, or ruptured from sudden stretching in fractures. This accident is not common; and it usually happens in such severe injuries that amputation is necessary: some cases, however, are left, in which laceration of an artery occurs as one of the complications of a simple fracture or of a compound fracture in which the other injuries are not very grave. In the latter case, no great difficulty can exist in deciding on the necessary treatment. If the limb is to be saved, the wound must be enlarged, and the wound of the vessel treated irrespective of the fracture. But when a large blood-vessel is wounded in a simple fracture, it is not always easy to make out in the first place whether the wounded vessel is an artery or a vein; and if the former, whether the main artery of the limb or one of its branches. In deciding between an artery and a vein, the chief guide, of course, would be the presence or absence of pulsation in the collection of blood; but then pulsation is often not perceived at first—not till the blood has become encysted, and the case therefore has changed from a wound of the vessel to a traumatic aneurism. Another important symptom is the state of the pulse below the injury; but this may be obscured by the ecchymosis and other swelling. Again, bruit may be heard at the seat of the injury; and this, although it does not quite settle the point,³ yet is perhaps the most accessible and trustworthy of all the symptoms.

Now, in such a case as this three courses are open: viz. to cut down on the seat of fracture and search for the bleeding vessel; to amputate the limb; or to leave the case to the powers of nature, aided of course by rest and suitable position.

¹ See a case of traumatic aneurism of the radial artery, cured by a combination of forced flexion of the elbow and compression of the brachial, and afterwards by extension of the arm (*Brit. Med. Journ.* 1860, p. 859).

² It will be remembered that Anel operated for a traumatic aneurism at the bend of the elbow.

³ A case occurred at King's College Hospital, in which, after injury, with protrusion of one eye, a bruit was distinctly heard over that side of the head. No hesitation was experienced in coming to the conclusion that the case was one of aneurism in the orbit, and the carotid was tied. The patient died; and after death no trace of aneurism could be perceived. The cause of the sound remained obscure. The case will be hereafter referred to under the head of 'Orbital Aneurism.'

In John Bell's 'Surgery' this species of traumatic aneurism is very fully discussed; and he seems to have been of the opinion that it was always necessary, in cases not severe enough to demand amputation, to cut down and tie both ends of the vessel.¹ That this severe operation is, at any rate, not always necessary, is clear from the fact that four cases have occurred at the Middlesex Hospital, under the care of Mr. Moore and Mr. Mitchell Henry, in which such traumatic aneurisms have formed and have got well spontaneously. Short notes of one of these cases, which was under Mr. Moore's care, may be appended, as illustrating the subject better than a lengthened disquisition.

A woman, aged forty-two, presented herself in the middle of the day, having on the previous night fallen downstairs and injured her right arm. The whole of the hand and fore-arm and part of the upper-arm were tensely swollen, and covered with bullæ of various but principally small size. Serum mixed with blood filled the bullæ. It was easy to make out a fracture of the olecranon; but it was impossible to perceive any fracture of the humerus, and the bones of the forearm appeared to be in place. She refused to come into the hospital, but was admitted next day. The swelling was then larger, and the vesications more extensive. There was an aneurismal pulsation in front of the elbow, strong and expanding, but deeply seated. The impulse extended half way up the inner side of the arm, and more than half way down the whole palmar surface of the forearm. A distinct bruit was heard with the stethoscope in front of the elbow. The two arteries at the wrist beat so forward and so forcibly, and appeared so much larger than those of the other side, as to give the idea that they had been raised by extravasated blood, and that the pulsation was communicated to the distended sheaths of the vessels. The skin of the hand was dusky from congestion; and when the colour was driven away by pressure, it returned very slowly, showing the embarrassed condition of the circulation. The limb was everywhere warm, however, and there was no sign of impending gangrene. A consultation was held, at which various opinions were expressed as to the appropriate treatment; but it was agreed that there could be no doubt that some large artery, possibly the brachial, was wounded. It was ultimately decided to watch the case. In the evening the swelling was found not to have increased, and the hand was certainly less tense. A rounded swelling was found near the armpit, in the neighbourhood of the brachial artery, which appeared to be the end of the clot of blood. On the following day (the third from the accident) pulsation had ceased in all other parts, and was perceptible only in front of the elbow, over a space about as large as a half-crown, and not strong. Next day the aneurismal pulsation finally disappeared, and the swelling afterwards gradually subsided. When the subsidence was sufficient, fracture of the lower end of the humerus was detected. The case did well.

Of the other three cases, one, under Mr. Henry's care, was a wound of the posterior tibial artery, in a boy who suffered from simple fracture of the leg. The diagnosis rested upon the absence of pulse in the artery, and the presence of bruit, together with peculiar restlessness of the limb. The fracture healed slowly (in about two months), and the above symptoms gradually subsided; but the pulse did not return in the affected artery. In the third case (Mr. Moore's patient), one of simple fracture of the femur in a man aged thirty-five, there was extensive swelling, together with arterial bruit in some artery—not the femoral—for that artery could be felt below the seat of injury. Here also the bruit and swelling disappeared with rest, and the fracture united in three months. The fourth case, also under Mr. Moore's care, was, like the second, a wound of one of the tibial arteries in fracture of the leg.

It will be noticed that the majority of these cases were merely wounds of the artery, and not aneurisms in the strict sense of that term: since they recovered without the formation of any aneurismal sac.² This fact seems to testify, even more strongly than the mere occurrence of spontaneous cure, to the decided tendency to recovery manifested by wounds of healthy arteries when uncomplicated by external injury.³ But if an aneurismal sac should form, its formation, far from being an unfavourable feature in the progress of the case, is part of the process of cure. It seems abundantly clear, therefore, that surgical interference in these cases can only be justified by the presence of alarming symptoms; and that, by the aid of simple position, and perhaps in appropriate cases light and even compression, a great number of arteries wounded in fracture will heal.

The clot sometimes softens, and suppuration occurs; and this again may lead to

¹ John Bell's *Surgery*, Charles Bell's edit. 1826, vol. iv. p. 404.

² Many other cases of lesion of arteries by fractured bones are on record. The above are only adduced as examples.

³ I would remind the reader of the many instances in which arteries have been wounded in subcutaneous section of tendons, and the rarity of consequent mischief.

the spontaneous cure of the injury. An interesting instance of this spontaneous ejection of the clot may be found in Ormerod's 'Clinical Collections,' p. 143, after rupture of the femoral artery in a child, the patient recovering, with only the loss of two toes by gangrene; but the limb was useless.

There are, however, no doubt, cases in which things do not proceed so favourably; and this unfavourable course tends in one of two directions—either that no aneurism forms, but the extravasation of blood increases, and thus the circulation is so far disturbed that gangrene is either commencing or appears imminent; or that an aneurism has formed, and its increase calls for some operation to check it. If no aneurismal sac has been formed, and the extravasation of blood is increasing, gangrene will soon commence. The only way to prevent it would be to cut down, as recommended by John Bell, upon the wounded vessel; but the opportunity will rarely occur. When gangrene has absolutely set in, it appears theoretically possible that a similar practice might be occasionally advisable; but in all the cases of which I have knowledge, amputation or death has been the alternative. Still, the relief to the circulation afforded by the removal of the extravasated blood might, in some rare cases of injury to the upper extremity, determine the surgeon to cut down upon the seat of injury, as a last effort to save a portion at any rate of a hand in which gangrene had absolutely commenced. This is a matter which would depend entirely upon individual judgment, based upon the symptoms of the case in hand. In the second case, that in which an aneurism has formed and is advancing, the treatment differs in no respect from that of aneurism in other circumstances and from other causes.

When aneurism has formed after lesion of an artery in a fracture, it is a sign that the cellular tissue is contracting upon the blood. This is very likely to lead to deposit of laminated coagulum in the sac. At any rate, it is highly improbable that the aneurism will begin to increase rapidly, since the patient is of course at rest and the limb in an appropriate position. Should it, however, increase, compression of the artery above will be the method most probably indicated, perhaps with gentle compression on the sac, if the fracture is sufficiently consolidated. If the fracture be firmly united, it may even be advisable to resort to forcible flexion. In cases, however, where a main artery is wounded, as well as in those where it is tied, the fracture unites very slowly. This may be noticed in the cases from Middlesex Hospital, quoted above, and has been observed by Dupuytren¹ and others; so that the treatment of traumatic aneurism from fracture, if it increase while the patient is lying in bed, will be by compression or ligature of the main trunk; and in cases so far resembling Mr. Spence's, quoted on p. 71, that the aneurism has apparently consolidated during the repose necessitated by the fracture, but recurs on the patient resuming his active avocations, the treatment there pursued (that of forcible flexion) will very probably be as successful as it was in that case, should the situation of the tumour render it applicable.

Aneurisms the result of fracture are not confined only to the arteries of the limbs, but may form in any part where an artery lies sufficiently near to a bone to be involved in the injury. Thus Mr. Busk and Mr. Curling have each put upon record a case in which a traumatic aneurism formed upon the ophthalmic artery as a consequence of fracture of the base of the skull.² In both cases the carotid artery was tied, and with complete success. (See below on 'Orbital Aneurism.')

Rupture of arteries.—The complete subcutaneous rupture of an artery from a blow, strain, or wrench, and the consequent extravasation of blood into the cellular membrane, is the form of injury which is usually, though incorrectly, called a 'diffused traumatic aneurism.' It should be called what it is, viz. 'rupture' or 'laceration' of the vessel. The injury is more commonly seen in the popliteal than in any other vessel, and next in the axillary, from obvious causes. The symptoms

¹ 'Sur les Anévrismes qui compliquent les Fractures,' &c., *Leçons orales*, tome ii. pp. 521, &c. Paris, 1839.

² *Med.-Chir. Trans.* vols. xxii., xxxvii. See also the first of Mr. Nunneley's cases in vol. xlii.

are, failure of the pulse below the seat of injury, great swelling of the limb from effusion of blood beneath the fascia, and remarkable loss of temperature. Pulsation cannot be detected unless the collection of blood is becoming encysted (*i.e.* the case is passing on to the formation of aneurism)—at least this has been the case in all the instances of this injury which I have seen. Bruit can usually be heard, but this symptom is variable. I regard the loss of temperature as a most valuable sign of the injury. In some cases the rupture may be at first only partial, and then some pulsation may be detected in the vessels below the injured part.¹ Mr. Poland² believes that in such cases pulsation is more likely to be found in the collection of extravasated blood than when the artery is completely ruptured.

The treatment of this injury must depend on the vessel involved. When the symptoms of rupture of the popliteal artery have been well marked, I have never seen a case in which ultimately amputation or death has not followed, nor can I find any recorded case which is to my mind satisfactory. Hence I think the best course is to amputate at once, when the loss of pulsation and the fall of temperature indicate plainly that the artery is completely torn across. In smaller arteries, and in those of the upper extremity, even as large a vessel as the axillary, the proper course is to cut down upon and secure the vessel. When partial rupture is suspected, a trial may be given to compression of the trunk leading to the injured part.³

The accompanying vein is often also ruptured, especially when the artery is torn completely across. I am not aware that any symptoms exist by which this complication can be distinctly recognised; but its known frequency constitutes an additional motive for amputation in such cases. Sometimes the popliteal nerve has also been torn, or the ligament of Winslow, or other structures of the joint.

ARTERIO-VEINUS ANEURISM.

Under this title are included two forms of aneurismal dilatation of an artery, communicating with a vein, known respectively as varicose aneurism and aneurismal varix.⁴

Varicose aneurism consists of a circumscribed consecutive aneurism, which communicates with the artery on one side and the vein on the other. The vein is always tortuous and dilated, sometimes to an enormous extent. In aneurismal varix there is no aneurismal sac: adhesion has occurred between the artery and the vein at the point at which they communicate, and the blood is projected directly from the artery into the vein at each pulsation. Here also the veins connected with the diseased part are greatly dilated, and the embarrassment of the circulation thus produced is the chief symptom of the affection.

The usual condition of a varicose aneurism is shown in fig. 15, drawn from a preparation in the Museum of University College. Another interesting peculiarity is also to be noticed in this preparation—viz. that there is a high division of the brachial artery, and that therefore a ligature placed upon what was supposed to be the brachial artery might have failed to cure the disease, being applied to the wrong vessel. Even if the right vessel alone had been tied, the other branch of the brachial anastomoses so freely just below the sac, that it might have prevented the formation of a clot. The hour-glass shape of the sac is attributed, in the Museum Catalogue, to constriction by the fascia of the arm.

Another and very unusual form of arterio-venous aneurism is shown in fig. 16, which is drawn from a preparation presented by Mr. Beaumont of Toronto to the Royal College of Surgeons. The patient died under chloroform, administered for the operation of tying the external iliac artery.⁵ In this singular case, the communication between the

¹ See a case under Mr. Brodhurst's care reported in the *Path. Trans.* vol. xvii. p. 74. Here the rupture seems to have been rendered almost complete by the exertion of taking a long walk. See also a case under Mr. Cæsar Hawkins' care, in *Poland, op. cit.* p. 24.

² 'On Rupture of the Popliteal Artery,' &c. from *Guy's Hospital Reports*, p. 32.

³ See an interesting case under the care of Gosselin, reported in *L'Union méd.* tome v. 1868, p. 546.

⁴ William Hunter was the first to describe arterio-venous aneurism accurately; and he also pointed out the difference between an aneurismal varix and a varicose aneurism, though he did not use those terms. See South's *Chelius*, vol. ii. p. 272.

⁵ *Med. Times and Gazette*, July 27, 1867.

artery and the vein appears to have persisted for ten and a half years (as evidenced by a continuous bruit, audible both to the patient and those near him), but the aneurism only formed at the end of this long period, whilst the patient was on horseback. The vein is here obliterated both above and below the aneurism; but there is a large opening between the vein and the artery. The usual signs of arterio-venous aneurism were absent, there being no venous murmur in the tumour, in consequence of the obliteration of the vein. In such a case the Hunterian operation, which Mr. Beaumont contemplated, would no doubt have cured the disease, had the patient avoided the risk of gangrene to which he was peculiarly exposed from the occlusion of the vein, and the pressure exerted by the tumour on the profunda artery.¹

Both varicose aneurism and aneurismal varix may originate spontaneously, though they are more commonly the result of an injury in which the artery and vein have both been wounded. By far the most frequent cause is the unskilful performance of venesection at the bend of the elbow. Hence the affection is rarely

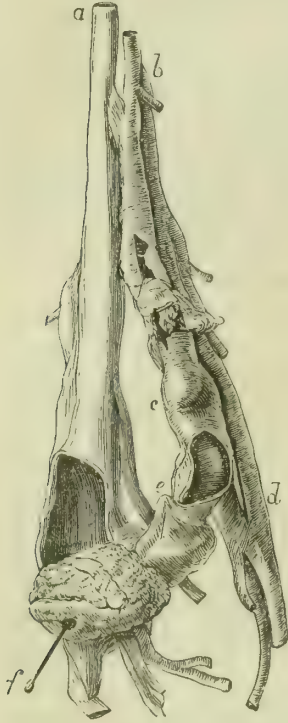


FIG. 15.—Drawing from a preparation by Sir C. Bell, of Varicose Aneurism after phlebotomy at the bend of the elbow, in the Museum of University College, London. There is a high division of the brachial. The artery on which the aneurism is seated is the radial, which communicates very freely with the ulnar by a large transverse branch just below the sac. A probe has been passed from an opening in the skin (probably the puncture of the phlebotomy) through the vein and aneurism into the artery. [a. The basilic vein. b. The brachial artery dividing above the usual level. c. The radial, on which the aneurism is seated, and which has been tied a little above this point. d. The ulnar anastomosing freely with the radial just below the aneurism. e. The arterio-venous aneurism, constricted at this part by the bicipital fascia. f. The probe passed through the puncture, made in phlebotomy, and from which hæmorrhage occurred during life.] The ulnar is said, in Sir C. Bell's account of the case, to have been tied also, but there is no trace of it. The patient died of mortification of the arm. (Sir C. Bell, 'Practical Essays,' pt. ii. p. 65.)

seen now, when the operation is not often performed, and only by surgeons. Any other punctured wound, however, may give rise to the disease, as the wound of a small shot, or the fragment of a comminuted fracture; and so, it is said, may a simple contusion.² Mr. Pemberton³ relates a very interesting case in which an arterio-venous aneurism formed in the groin ten months after the cure of an aneurism in the leg by prolonged instrumental pressure at the spot where the disease afterwards showed itself.

In spontaneous arterio-venous aneurism, the communication with the vein

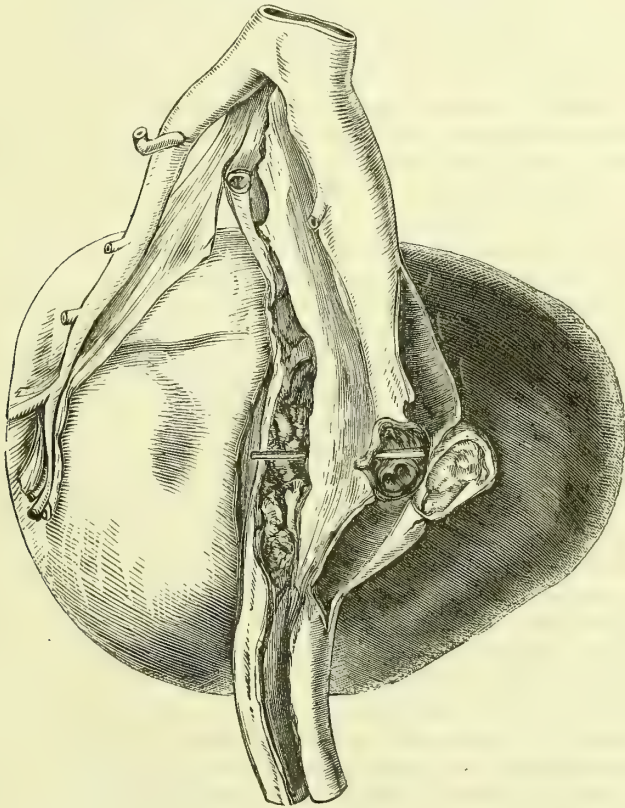
¹ An interesting case of a wound of the profunda femoris and its accompanying vein, treated by ligature of the external iliac, with a fatal result, will be found in the *Gaz. hebdomadaire*, 1864, p. 166.

² It is perhaps worth notice that the communication may occur between two vessels which are not naturally in contact, but which have been brought together by the force which inflicted the wound. Thus in the Museum of St. Bartholomew's Hospital, there is an interesting preparation (ser. xiii. No. 121), in which a small sac is formed communicating with the internal jugular vein and the external carotid artery. The cause was a punctured wound from the point of a pickaxe, and a small fragment of the iron has lodged and is impacted partly without and partly within the cavity of the vein.

³ *Med.-Chir. Trans.* vol. xlv. p. 189.

apparently follows upon the development of a simple arterial aneurism in the contiguity of a vein. When an aneurism is formed on a large artery, in such a part of the artery as to compress a neighbouring vein, it is common to find that vein obliterated; and in the museum of every hospital there may be seen preparations showing the obliteration thus effected of the largest veins, the *venæ cavæ* being frequently so occluded. But occasionally, in lieu of effecting the closure of the venous channel, the pressure of the aneurismal pouch of the artery gives rise to absorptive ulceration of the coats of the vein, and the sac opens either by rupture or by ulceration into that vein. This happens especially within the thoracic and abdominal cavities, when aortic aneurisms press upon the great venous trunks of the chest and abdomen.¹

FIG. 16.—Arterio-venous Aneurism of the Superficial Femoral Vessels. (From the Museum of the Royal College of Surgeons.)



Less frequently, arterio-venous aneurisms arise in the same way on the limbs, and on other parts of the trunk. Sometimes these occur long after the infliction of a wound which had affected the artery, but which had been perhaps almost forgotten.

Thus Rokitsky observed an axillary aneurism of this kind thirty years after a shot had taken effect on the spot. Roux² relates a case in which arterio-venous aneurism at the elbow formed four years after venesection; and Monneret³ has described an aneurismal communication between the femoral artery and the vein, said to have arisen twelve years after injury from a shot. This was also the case with Mr. Beaumont's patient, fig. 16.

¹ The earliest and most complete monograph on these forms of aneurism is due to Thurnam, *Med.-Chir. Trans.* vol. xxiii. See also Rokitsky, *Ueber einige der wichtigsten Krankheiten der Arterien*, Wien, 1852, p. 46 *et seq.*; Porter, on 'Arterial Disease,' in *Todd's Cyclopædia of Anatomy*; Nélaton's *Clinical Lectures*, by Atlee; Mayn, *Dublin Medical Journal*, 1854.

² *Bulletin de l'Acad. de Méd. Paris*, 1849.

³ *Bulletin de Méd. et de Chir.* 1852.

Again, spontaneous arterio-venous aneurism has been described by Bransby Cooper,¹ by Perry,² and Porter,³ affecting the femoral vessels in cases where the aneurism could not be traced to any other cause than primitive disease and thinning of the coats of the vessels. In the highly interesting case related by Mr. Perry there was more than one communication.

It is usually a main artery and its collateral vein which are thus affected; and it may be readily understood that, from their close contiguity and often superficial position, these would be more likely to become the subjects of this diseased connection; but the elaborate investigation of MM. Follin and Charnal,⁴ and the cases of Puydebat⁵ and Pancoast,⁶ have shown that deeply-seated veins, as well as superficial veins, may be thus affected.

In the case of M. Follin, a communication between the brachial artery and a deep vein was diagnosed during life, and subsequently proved by the dissection of M. Charnal. Schottin⁷ has seen a similar connection between the radial artery and the cephalic vein. Moore⁸ relates a case in which an arterio-venous aneurism was found in the trunk of the popliteal nerve, as a result of a blow on the part, which appears to have produced rupture of a small artery and its companion vein in the substance of the nerve.

These two forms of arterio-venous aneurism have some symptoms in common due to the communication between the artery and vein. The most characteristic is a vibratory thrill, which results from the impulsion of the arterial blood into the patent aperture of the vein, there to mingle with the venous current. The greater tension of the arterial than the venous wall, and the greater force of the arterial flow of blood, causes a continuous injection of arterial blood into the venous tumour; but the pulsation of the artery produces a synchronous impulse in the flow of the blood through the tumour. Hence the peculiar vibratory or pulsatory character of the thrill, which is otherwise continuous. The ear detects a harsh, buzzing sound, which has been variously compared to that of a saw, a file, a bee, the hissing of burning metal plunged into cold water, and similar noises. This sound too is continuous, although momentarily increased during pulsation. It grows fainter on being propagated along the artery, and at some distance from the aneurism in which it arises it seems intermittent, the louder pulsatory sound only being then heard. This sound may be so loud as to be audible by a person standing near the patient; but that is exceptional. It may, however, always be distinctly heard with the stethoscope, or by the naked ear; and its continuous character sharply distinguishes an arterio-venous from a pure arterial aneurism. Considerable dilatation of the veins, a third symptom, is consequent upon the obstruction of the venous circulation by the entrance of arterial blood flowing in an opposite direction, and upon the general increase thus made to the quantity of blood which the vein must carry towards the heart. The extent of this dilatation varies according to the size and importance of the vessels affected. It is most marked in the lower limbs, where gravity aids in increasing the obstruction and consequent tendency to varicosity. Here the veins have been described like knotted ropes beneath the skin by Porter, Perry, Laugier, and others. In Mr. Moore's case, where the temporal vessels were affected, the veins were enormously dilated, and pulsed so strongly as entirely to simulate arteries during the operation performed.⁹

This pulsation of the veins is a fourth important symptom which deserves to be borne in mind; because the surgeon may be, and has been, induced by it to place a ligature round one of the veins, thinking it to be an artery. William Hunter noticed that the arteries below the point of communication beat more feebly than in the healthy body; and naturally, since a part of their ordinary supply of blood is directed into the vein. But this symptom is not always observed. The temperature of the part, and the growth of hair on the skin, are sometimes augmented below the communication. In old-standing cases, a remarkable condition of dilatation is

¹ *Guy's Hospital Reports*, vol. v.

³ *Todd's Cyclop.* 'Arteries,' p. 242.

⁷ *Bulletin de la Soc. anat.* 1834.

⁸ Schottin, *Merkwürdiger Fall einer aneurismatischen Venengeschwulst*. Altenburg, 1825.

⁶ *Med.-Chir. Trans.* xlix. p. 29.

² *Med.-Chir. Trans.* vol. xx.

⁴ *Bulletin de la Soc. de Chir.* vols. iii. v.

⁵ *Fergusson's Handbook of Surgery*, 1852.

⁹ *Ibid.* vol. xli. p. 1.

observed in the arteries above the varix. They become enlarged, tortuous, and thinned in structure. Indeed, the veins around the arterio-venous aneurism assume more or less of the arterial character, and the arteries approach somewhat the type of veins. This has been observed by all who have described these cases, and is well summarised by Rokitsky in his monograph on the pathology of the arteries.

The varicose aneurism differs from the aneurismal varix, as we have seen, in that it possesses an aneurismal pouch which is intermediate between the opening of artery and vein. It is, of course, important in practice to recognise this difference, and mark its peculiar symptoms. This circumscribed aneurismal tumour will be found of various size and density, according to the site and duration. It rarely attains, however, any considerable size. It is affected in the same way as pure arterial aneurisms when the artery is compressed above or below it, and the ear detects the blowing sound of an aneurism, in addition to that rasping bruit described as the result of the venous communication.

In both forms of arterio-venous aneurism it may be said that we find a soft, fluctuating, knotted, and imperfectly circumscribed subcutaneous tumour. It can be emptied by pressure upon the tumour itself, or the artery leading to it. It has distinct pulsations; but these are limited to a very small part of the swelling at the level of the point of communication between the vessels, gradually becoming extinct in the ratio of distance from that point. In this it is distinguished from arterial varix or cirroid aneurism, which offers pulsation of equal intensity over the whole extent of the tumour; it may be further distinguished from that affection by the blue or purple colour of the tumour, and by the tortuous dilatation of the veins leading to it. Further, to distinguish it from arterial varix, to which it presents so many points of external resemblance, it may be added that while in both auscultation detects a loud rasping, continuous bruit, this sound is heard over the whole surface of the arterial varix, but only at the point of communication in the arterio-venous aneurism, or, if it radiates therefrom, it can then only be traced along the course of the artery, and becomes gradually extinct.

Treatment of aneurismal varix.—The treatment of aneurismal varix and varicose aneurism must be mentioned separately; that of aneurismal varix presents great difficulties. In many cases, indeed, the disease manifests but little tendency to advance; and where this stationary condition exists, surgical interference may well be omitted. In Mr. Moore's case, thirty-six years had elapsed before any operation was necessary; and Hunter, Clegghorn, Porter, and indeed all other authorities on this subject, have seen this occur. It is especially the case in the upper extremity. In the lower limb, however, the disease may extend so greatly as to destroy the use of the limb, or to threaten the destruction of the patient's life by hæmorrhage. In the case referred to, as related by Mr. Perry, the Hunterian ligature was twice performed, but without effecting the cure of the disease. In a case mentioned by Mr. Bransby Cooper, it was considered necessary to amputate the leg. Should the surgeon now be called upon to treat, by operative means, an artery so affected in either of the extremities, he would probably attempt to obtain the closure of the arterial aperture by indirect pressure on the artery above the communication. The use of direct pressure has rarely been of any good effect. There are, however, two proceedings which are more promising: the injection of coagulating fluids at the site of the disease, applied carefully, with the minute precautions necessary for the success of that plan; or ligature of the artery above and below its aperture of communication. Before employing either method, it would probably be desirable to resort to digital or instrumental compression, or, if the position allowed, to forcible flexion. But the constant passage of the arterial blood through the apertures, resulting from the arterio-venous communication, and the absence of any defined sac, impede the formation of the fibrinous deposit to which these methods owe their success; and cases of aneurismal varix of this form are not very amenable to treatment by indirect compression. An interesting case is recorded in the 'Proceedings of the Anatomical Society of Paris,' for 1858, in which indirect compression having been carefully tried, but without success, a ligature was applied by M. Robert above the

aperture in the artery. A few cases have been recorded of aneurismal varix within the skull.¹ In one of these, recently, compression was applied over the carotid, but ineffectually; in this case, the internal carotid artery communicated with the cavernous sinus, and death occurred as the result of profuse hæmorrhage from the nose. In such cases, of course, only the Hunterian ligature is possible; but where the artery is more accessible, it is obviously more desirable to apply a ligature above and below the diseased communication.

The treatment of varicose aneurism is somewhat different in kind; for here a sac intervenes between the artery and the vein, but it is similar in principle. Here also direct and indirect compression have been largely tried. In general such trials have not been very successful. M. Nélaton, however, has succeeded four times in converting a varicose aneurism at the bend of the elbow into a simple arterial aneurism by direct pressure. Cure was then in all cases effected either by ligature, or compression of the brachial artery.² Digital compression might be employed in the simpler cases, not without hope of cure, and the method of applying it has been well described by Vanzetti. It consists in making pressure lightly over the orifice of communication between the tumour and the vein, so as just to suspend the continuous thrill in the tumour, and then applying pressure to the artery, simultaneously, at a higher point. The same person may perhaps accomplish this with his two hands, but it would be more easy and more likely to succeed if done by two well-instructed persons. Successful cases of this treatment in arterio-venous aneurisms at the bend of the elbow will be found recorded in a lecture published in the 'Lancet,' Oct. 25, 1873.

Should it be necessary to apply the ligature, the artery must be tied on both sides of its opening into the sac. The most simple plan is to lay open the sac, trace it into the artery, and having exposed the aperture in the artery, for which purpose it is commonly necessary to divide the sac transversely on a director, then to apply a ligature above and below the arterial opening. This method is more simple than that which has been employed by Roux and Fergusson, who have endeavoured to isolate the artery, and tie it above and below without opening the sac at all.³ This is the more difficult, that the artery below its point of communication is small, and surrounded by veins dilated and closely packed. On the other hand, it is free from the objection attaching to the plan first described, arising out of the danger of putting two ligatures close to the sac, and at a point where it is surrounded by dilated veins. Mr. Annandale has related two cases of traumatic arterio-venous aneurism, successfully treated by the ligature of both the wounded vessels in the sac, the latter having been laid open and emptied of its contents. The vessels affected were in one case⁴ the popliteal artery and vein in a child, æt. 10, operated on three months after the accident; and in the other⁵ the posterior tibial artery and one of its venæ comites in a lad, æt. 20, operated on three days after the accident. I think this operation unquestionably superior to any other operative method of treating the disease, provided it is undertaken early enough—*i.e.* before the coats of the artery have become too much altered to bear the ligature. In any case the operation is peculiarly liable to one of two secondary accidents, hæmorrhage and gangrene: hæmorrhage from the part of the artery above the sac where it is dilated, thinned, and gives rise to numerous collateral branches; and gangrene of the limb below, which perhaps already, before the operation, was cold, benumbed, and œdematous. The injection of a weak solution of perchloride of iron has been employed by Serres and Jobert,⁶ Velpeau,⁷ and Vallette,⁸ twice with perfect success; once producing suppuration of the sac followed by cure, and once, by M. Velpeau,

¹ *Bulletin de la Soc. anat.* vol. xxix. 1859, p. 298, and vol. xxx. p. 178.

² *Journ. de Méd. et Chir. prat.* 1862, p. 155.

³ This operation was performed successfully by Mr. Spence in a case of arterio-venous aneurism of the femoral artery (*Edin. Med. Journ.* July 1869).

⁴ *Lancet*, April 25, 1875.

⁵ *Ibid.* Oct. 14, 1876.

⁶ *Bulletin de l'Acad. de Méd.* 1854.

⁷ 'Traitement de l'anévrisme artério-veineux,' *Bulletin de l'Acad. de Méd.* 1854.

⁸ *Acad. de Méd. Paris*, May 23, 1859.

ineffectually. These facts are in favour of this method of treatment; and as the safeguards against the accident of suppuration are more carefully studied, this plan may recommend itself still more strongly to the surgeon.

Galvano-puncture has been employed by Bosse and Capeletti. In Bosse's case two steel needles, connected with thirty-two pairs of galvanic plates, were introduced into the aneurismal tumour, and retained there for eighteen minutes. The cure was completed within ten days. In Capeletti's case the needle was introduced twice; suppuration followed and ultimately a cure. M. Debout has also recorded a successful case.¹

There will be cases in which an expectant treatment will be most advisable, and others in which amputation might be the only available measure.

Thus a case is reported in the 'Journal de Méd et Chir. pratique' for 1862, p. 155, under M. Nélaton's care, in which a man was suffering from an arterio-venous aneurism of considerable size, in the ham, the result of a punctured wound of the popliteal artery. M. Nélaton recommended that no operative measures should be adopted, believing that the aperture of the aneurism into the vein was sufficiently free to render the bursting of the tumour improbable; and he remarked that the only efficient measure for the radical cure of the disease would be the old operation for aneurism, and this under the circumstances he held to be so difficult and dangerous, that if driven to operate, he should prefer amputation.

CIRSOID ANEURISM, AND ANEURISM BY ANASTOMOSIS.

By cirroid aneurism is understood a form of disease which consists in a simultaneous elongation and dilatation of an artery. The structure of its wall exhibits in the beginning no alteration, although the coats become thinned during the progress of the enlargement. It will be observed that this lesion is not strictly included in the terms of the definition which was given of aneurism, and recent authors have agreed that this disease is improperly denominated aneurism. But it seems practically most convenient to describe it here.

It is especially the middle coat of the artery which is affected when the process of thinning commences. This structure becomes pale, soft, and thin, so that the arteries look like thin veins. The dilatation is commonly equal throughout the circumference of the artery; but in the more severe cases the artery is greatly dilated, and presents unequal saccular pouches, which are, in fact, so many true aneurisms, projecting usually towards the surface of the skin. As the artery elongates, it becomes tortuous and serpentine; sometimes even spiral. The disease is rarely circumscribed, but attacks commonly several trunks and their branches. M. Broca, however, has described a case of perfectly circumscribed cirroid aneurism of the scalp, treated

FIG. 17.—Cirroid Aneurism of the Scalp. (From a drawing in the Museum of St. George's Hospital.)



¹ See Wernher, *Hand. d. Chir.* iii. 821; Ciniselli, *Sulla Elettropuntura nella cura degli Aneurismi*. Cremona, 1856; Debout, *Bulletin de Thérapeutique*, 1847, p. 123.

successfully by the injection of perchloride of iron.¹ It may occur in the arteries of the extremity, and Cruveilhier has reported a remarkable case of cirroid aneurism of the external iliac artery.² But it is more especially frequent in the arteries of the scalp, and in this situation more instances have been recorded than in all the other parts of the body taken together. Originating usually in one of the arteries of the scalp, it extends itself to the branches of the other side of the head, and may implicate the neighbouring vessels to a variable extent. On the one hand, it may pass into the capillaries, widely dilating them, and spreading into the veins; or, on the other, but in a smaller degree, it may spread upwards to the larger branches from which the arteries of the scalp arise, passing even into the carotids. It is thus that it changes somewhat its anatomical characters. The venous capillaries and trunks become affected by the extension of the disease, and the arterial network becoming highly and morbidly developed, this form is known by the name of *aneurism by anastomosis*. The pathological condition and the principles of treatment are essentially the same; but when the disease is seated in the larger arterial trunks, it is commonly known as cirroid aneurism; when it extends into the network of capillaries, it is known as aneurism by anastomosis, or racemose aneurism. It attacks most frequently the superficial temporal, the posterior auricular, and the occipital arteries. Commonly the surrounding tissues suffer but little injury; but sometimes the subcutaneous cellular tissue may be atrophied, and the skin dangerously thinned; at other times the soft parts may be thickened and indurated; sometimes the bones are grooved, or even perforated.

M. Gosselin³ has endeavoured to subdivide cirroid aneurisms into three classes: arterial varix, when large arteries are affected (as in Cruveilhier's case); cirroid arterial tumour, when the smaller arteries are affected, forming a circumscribed lobulated pulsatile tumour; and aneurism by anastomosis, when the capillaries and skin are involved. The distinction is a real one in many cases, and useful to recollect, having an important bearing on practice; but the three forms are too much mixed together to enable us to accept it as a classification of the disease. The second class are those in which coagulating injections, according to M. Gosselin, are likely to succeed; and I would add that in the third class galvano-caustic or extirpation are the methods usually indicated.

The causes which give rise to cirroid aneurism are not apparent. Occasionally its origin has been referred to a blow, or to an injury of a congenital erectile tumour; more often no cause can be assigned, and it is not evident why the scalp should be the chosen seat of this disease. It may be noticed here that the majority of cases occur in persons whose age varies from fifteen to thirty. The diagnosis of the disease can hardly be a source of difficulty, for the serpentine and pulsating character of the tumour afford a distinguishing sign. The manner of diagnosing this affection from varicose aneurism or aneurismal varix has been mentioned in the last section. But where it is associated with dilatation of the veins, some difficulty may arise in distinguishing it from the so-called erectile tumour, or teleangiectasis, from which it is, however, still distinguished by its pulsations. Such cases have been recorded by Pelletan,⁴ by Dupuytren,⁵ and others.

The treatment of cirroid aneurism commonly offers great difficulties and many risks. The frequency with which direct failure has followed various procedures, the yet greater frequency of relapse, and the occasionally fatal termination of operations which have been undertaken, are reasons for caution. Unless there is reason to fear that by its extension or by its severity it may prove fatal to life, it is commonly the more prudent course to abstain from operative interference. Cirroid anastomosing aneurism is not always a source of imminent danger, and it may exist for many years without any other evil effect than that of inconvenience; and, indeed, in some

¹ *Bulletin de la Soc. de Chir. de Paris*, 1859.

² See also Cocteau, 'Sur les Varices artérielles des membres,' *Arch. gén. de Méd.* 1865, p. 666.

³ *Arch. gén. de Méd.* 1867.

⁴ Pelletan, *Clinique chirurgicale*, vol. ii. p. 59. Paris, 1810.

⁵ Dupuytren, *Leçons orales*, vol. v. p. 43. Paris, 1839.

of the least unfortunate cases, it has so continued after various operations. Even where extensive and severe, it cannot always be treated with advantage.

The simplest method of treatment is by compression; but this is also the most ineffectual. I am not acquainted with any case in which it has proved successful, although trials have been recorded by Dupuytren, Robert,¹ and Brodie.² If palliation be desired, little more can be done than to provide a metal covering to protect the affected part, where the locality admits of such a provision. The ligature of the branches directly leading to the affected part has been often tried; but this also has rarely succeeded. In a case in which Breschet tied the temporal artery in a girl eighteen years of age, for a severe form of the disease, death from pyæmia took place on the fourteenth day,³ the ligature having been carried through and not round the vessel. Maclachlan tied the temporal artery, also without success, and followed it by ligature of the common carotid.⁴ In a patient of Dupuytren's, both the temporal and occipital arteries had been tied unsuccessfully.⁵ Gibson in a similar case tied the main branches of the temporal and occipital artery ineffectually.⁶ The records of the results of this proceeding are not in its favour.

The ligature of the external carotid has been performed for a cirroid aneurism of the scalp by Maisonneuve.⁷

He tied the right external carotid for a cirroid aneurism of the right temporal artery occurring in a woman thirty years of age two months after a blow. As the patient was suffering acute pain, and the disease beginning rapidly to extend, besides tying the external carotid, he put a ligature also round the superior thyroid artery. Pulsation ceased, the tumour diminished, and all went well for the first three weeks. Secondary hæmorrhage followed the separation of the ligature, and Maisonneuve tied successively the common and the internal carotid arteries. The latter operation was followed by hemiplegia, and, after three days, by death. The brain-substance of the right hemisphere was found to be deliquescent. This case had, therefore, a very unfortunate termination; but it is worthy of especial note, because it is, perhaps, the only recorded instance in which the external carotid artery has been tied for cirroid aneurism of the scalp, and because that proceeding would appear on anatomical grounds to be the best calculated to arrest the circulation in the part affected.

Prof. Bruns,⁸ who has given great attention to this subject, points out that the ligature of the external carotids is the proceeding best calculated to cut off the supply of blood to aneurisms of the scalp. He urges that the external carotids of both sides should be ligatured in such cases, and certainly where it is necessary, from repeated local hæmorrhages or threatened rupture, to employ serious surgical interference, the ligature of one, and still more of the two external carotids, would best effect the diminution in the supply of blood to the arteries in the scalp; for then only the supra-orbital and frontal branches of the internal carotid would remain capable of supplying blood in this direction; and unless the disease were seated in the forehead, their influence need hardly be feared. Posteriorly the blood would reach the scalp only through the anastomosis of the occipital arteries with the ascending cervical branches of the subclavian and the muscular twigs of the vertebral artery; whilst in front some further assistance would be given by the connection of the inferior thyroid branch of the subclavian with the superior thyroid branch of the carotid. This suggestion might not be unworthy of the consideration of surgeons in future cases.

Judging from anatomical data, the ligature of the common carotid artery, while it is pregnant with greater dangers, offers fewer advantages than the application of the same procedure to the external carotids. It has, however, been practised in at least fifteen cases, but its successes have been few. The only superiority which it possesses over the ligature of the external carotid is by shutting off the supply

¹ *Gaz. des Hôpitaux*, 1851, p. 130.

² *Lancet*, 1828-9, vol. ii. p. 559.

³ Breschet, *Mémoires chirurgicaux sur les différentes espèces d'Aneurismes*, p. 54. Paris, 1854.

⁴ *Lancet*, 1827-8, vol. i. p. 773.

⁵ *Leçons orales*, loc. cit.

⁶ *Institutes and Practice of Surgery*, vol. i. Philadelphia, 1835.

⁷ *Bulletin de la Soc. de Méd. de Paris*, 1851, vol. i. p. 400.

⁸ *Handbuch d. pract. Chir.* i. p. 161. Tübingen, 1854.

through the branches of the ophthalmic artery; but the large and numerous anastomoses of the carotid of the opposite side continue to supply blood, and even where a temporary improvement has followed the operation, speedy relapse has occurred, probably from this cause. Again, the disturbance of the cerebral circulation by ligature of the common carotid has of course its own peculiar dangers. So that out of eighteen cases in which the operation was performed, death occurred under the knife in three instances, and four others terminated fatally; in five an early relapse followed the first improvement; in the tenth case no final report has been given; and in only two it is stated that there was lasting improvement. Instances in which the common carotid has been tied for this disease are recorded by Robert,¹ Dupuytren,² Kühl,³ Bush,⁴ Wardrop,⁵ MacLachlan,⁶ Maisonneuve,⁷ Walther,⁸ Mussey,⁹ Warren,¹⁰ Hersche, Kerr, Zeiss, Arend,¹¹ Travers junior,¹² Mott, Wood,¹³ and Critchett.¹⁴ A proceeding which has proved so fatal in the hands of surgeons so eminent must be regarded with great distrust. It is certain that in very many cases the dangers of this operation must be greater than those of the disease itself; and when those perils are surmounted, its success must still remain a contingency, which in the past has only three times been nominally realised in eighteen cases. Mr. Southam has¹⁵ however recorded a case in which the ligature of the common carotid was successful when combined with the use of setons. Attempts have been made to cure cirroid aneurisms by a method conceived after the old proceeding of Antyllus for true aneurisms. It has been proposed to lay open the tumour by a stroke of the scalpel, to stuff the arterial wound with lint, arrest hæmorrhage by firm compression, and trust to the inflammatory exudation thus excited for the obliteration of the arterial channel. It is obvious that this method could only be applied to those cases of circumscribed cirroid aneurism in which the artery forms a limited tumour by its convolutions, and to cases of limited aneurism by anastomosis. Gräfe first employed this proceeding for a cirroid aneurismal tumour of the forehead in a boy aged ten.¹⁶ He divided it across with a strong scalpel, stuffed the wound quickly with agaric and sponge, and firmly strapped and bandaged the whole. On the following day, as the pressure was slightly relaxed, the wound granulated, and when the parts healed there was no pulsation in any part of the solidified tumour, Bell,¹⁷ Arnott, and Lawrence,¹⁸ have succeeded also in curing aneurism by anastomosis, by incising the soft parts, and promoting suppuration in the tumour, maintaining meantime compression. It would not be reasonable to expect that the obliteration of a single large artery in a state of cirroid dilatation could commonly be satisfactorily effected in this way; not only the fear of secondary hæmorrhage presents itself, but we know that arteries are but little prone to adhesive inflammation, and that arterial blood is quick to find outlets and make channels for itself. In a case of truly cirroid aneurism, this proceeding will almost certainly fail.

A more efficient means of destroying circumscribed cirroid aneurism is to be found in extirpation *en masse* by the knife or by ligature. The latter method was employed by Sir B. Brodie with only temporary success in treating a cirroid and anastomosing arterial tumour of the head of the size of a walnut, which had the

¹ *Gaz. des Hôpitaux*, 1851, pp. 130, 128, and *Bulletin de l'Acad. de Méd.* vol. xvi.

² In this case of Dupuytren the right common carotid was tied in 1809. The tumour remained stationary till 1848, when it again became very much ulcerated, and gave rise to frightful hæmorrhage. The patient came under the care of M. Robert at the Hospital Beaujon in 1857, when the left carotid was also tied, with temporary success.

³ Kühl, *Opusc. Academica*, editio Claras; Leipsiæ, 1842, p. 51.

⁴ *New York Journal*, &c. 1819, vol. i.

⁵ *Lancet*, 1827-8, vol. i. p. 24.

⁶ *Glasgow Medical Journal*, 1827.

⁷ *Supra cit.*

⁸ *Gräfe und Walther's Journal*, vol. v.

⁹ *Amer. Journal of Med. Sciences*, 1830.

¹⁰ *Practical Remarks on Tumours*.

¹¹ Quoted by Wernher, *Handb. der Chir.* vol. iii. p. 806. Giessen, 1855.

¹² *Lancet*, vol. ii. 1857, pp. 497, 627; vol. i. 1858, pp. 75, 399 (see also below, on p. 97).

¹³ *New York Journal of Medicine*, 1857.

¹⁴ *Statistical Reports Med. Times and Gaz.* vols. xxx. and xxxi.

¹⁵ *Med.-Chir. Trans.* xlvi. 65.

¹⁶ *Gräfe und Walther's Journal*, vol. xviii. p. 20.

¹⁷ Bell, *Principles of Surgery*.

¹⁸ Lawrence, *Med.-Chir. Trans.* vol. ix.

characteristic feeling as of a convolution of meandering vessels with strong pulsations. The tumour was transfixed crosswise, and strangulated by four threads in as many parts. The cure was reported at the time to be complete.¹ But Mr. Prescott Hewett mentioned, in a lecture at the Royal College of Surgeons, the fact that the disease recurred in this case, and that the patient died some years afterwards, death being attributed to 'nervous debility.'

Excision of the tumour by the knife has been several times accomplished, and has yielded cures in cases of great severity.

Mussey's² case is one of the most remarkable on record. The patient, a young man aged twenty, had on the top of his head a cirroid aneurism of great size. All the arteries of one side of the head were enormously dilated, and when the head was shaved, twenty arteries of the size of a goose-quill were felt which led to the tumour. Ligature of the left common carotid failed to cure, and the ligature of the right common carotid twelve days later also effected only a temporary improvement. Extirpation was resolved upon; two semilunar incisions being made around the tumour, which was then peeled off from the pericranium. These incisions were made gradually; the arteries wounded being tied at each half-inch: this occupied more than an hour, and forty ligatures were required. In spite of all precautions, there was a great quantity of blood lost, and the patient fell into syncope; the wound, however, granulated, and the patient is stated to have recovered completely.

Gräfe,³ Gibson,⁴ Weitzer,⁵ Busch, Warren, and Guéniot⁶ have also employed this method. Mr. Hart employed it successfully; freezing the tumour and cutting wide of it, so that very little blood was lost. The difficulties of this method, however, have proved very great, and its danger is considerable. The hæmorrhage in some of these cases was excessive. But the issue of all the recorded cases in which it has been undertaken has been successful, and excision by the knife has as yet proved a most rapid, safe, and successful means of treatment. It is obvious that great skill and caution are required to carry it into effect, and in very extensive developments of the disease it will be inapplicable. It might commonly be prudent to preface the extirpation of the tumour by the ligature of the main trunks which feed it; when practising the incisions around the tumour, the knife should travel slowly, and the arteries are to be tied as they are divided. It was by the combination of well-timed caution and necessary boldness that some of these formidable operations have been brought to a successful issue.

Cirroid aneurisms have also been treated by galvano-puncture, galvano-caustic, and coagulating injection.

In a case under Nélaton's care, treated by galvano-puncture, the patient was a woman aged twenty, having a tumour on the forehead, made up of convoluted vessels, the coils of which could be clearly distinguished by the touch; it had arisen two or three months before after a blow. Two needles, connected with a Bunsen's pile of thirty couples, were passed into the tumour where the pulsations were the most violent, and the current was transmitted through them for ten minutes. Next day, consolidation was found to have taken place where the positive needle had entered, and after some further sittings the whole tumour had become a hard mass, which was gradually absorbed.⁷ Dr. Duncan⁸ has recorded four cases of cirroid aneurism successfully treated by electrolysis.

The case of aneurism by anastomosis of the ear and scalp, in which (as mentioned above) the common carotid was tied with a fatal result by Mr. Travers, jun., had been previously under the care of Mr. Cutler and Mr. Prescott Hewett at St. George's Hospital. It was then treated by a combination of the electric cautery, styptics, and ligature of portions of the tumour. The result was very satisfactory: all bleeding ceased, the tumour in great part sloughed away, the ulceration healed, and the greater part of the hypertrophied vessels resumed their natural appearance. The patient remained free from dangerous symptoms during an interval of three years, when the tumour gradually returned and bleeding recommenced. Mr. Travers was sent for to see him in the country, and tied the common carotid artery; but the patient died of hæmorrhage, which commenced while the ligature

¹ *Med.-Chir. Trans.* vol. xv. p. 177.

² *Loc. cit.*

³ *Gräfe und Walther's Journal*, vol. xiv. p. 639.

⁴ *Op. cit.*

⁵ *Deutsche Klinik*, 1850.

⁶ *Gaz. des Hôp.* 1868, p. 153. This author remarks that the fact of the incision being carried a little within the tumour, so as to leave a few pieces of the morbid tissue, is rather advantageous; the tissue is supple and the arteries are easily tied in it; it speedily melts away as the wound suppurates.

⁷ *Bull. de Théor.* tome xlii. p. 354.

⁸ *Brit. Med. Journ.* vol. i. 1876.

was still on the vessel; a striking proof of the inefficacy of that method of treatment. Had the case been kept under observation, and the original measures repeated from time to time, as fresh growth occurred, there is every reason to believe that this man's life would have been saved.

The application of coagulating injections (perchloride of iron) was made by M. Broca to a circumscribed aneurism of the scalp, consisting of the convolutions of a cirroid artery. Many precautions were taken to prevent the extravasation of the fluid, and the case is reported as perfectly successful.¹ Another successful case is reported by M. Demarquay, in a large aneurism by anastomosis of the palm of the hand and middle finger, occurring in a child after the blow of a stone. Here the radial and ulnar arteries, however, were first tied.²

M. Gosselin (see p. 94) advocates the use of coagulating injections in all those cases of the disease to which he wishes to limit the designation of 'arterial cirroid tumours,' i.e. those of limited extent, and formed apparently by the dilatation of minute arteries—not capillaries. He gives three cases—one in the leg, one on the forehead, and the other at the root of the nose—in which this treatment was successfully adopted.

Before quitting the subject of cirroid aneurism, it may be well to notice that the disease is said to have occasionally undergone spontaneous cure. A patient was exhibited by Dr. Krackowizer to the New York Pathological Society in whom this had occurred, at any rate to a great extent; pulsation having disappeared, and the tumour having become solid and shrivelled in some of its parts; and the continuous rushing noise formerly perceptible to the patient being now inaudible while he was quiet. The patient was forty-five years of age, and the disease had lasted all his life, and had grown to a considerable size, but without pain or hæmorrhage. In the same communication, Dr. Krackowizer referred to two other cases as being recorded by Orfila and Chevalier.³

DISSECTING ANEURISM.

The affection which bears the name of Dissecting Aneurism is so seldom recognised during life, and when it is the subject of treatment falls so much more commonly under the care of the physician, that a very few words must suffice for its description here. The anatomical lesion consists in a rupture of the internal coats of the artery, by which the blood is allowed to pass in an unnatural channel between the coats of the vessel, parallel to its course, until finally it either passes again through the coats, so as to enter the cavity of the artery again, if its course has been forwards, or falls back into the pericardium if it has made its way backwards; or else makes its way into the cellular tissue outside the vessel. Dr. Peacock⁴ has shown that a layer of the middle coat usually is left external to the blood, which is therefore extravasated into the thickness of this coat. When the coverings of the blood are strong, and the fluid finds a ready passage back into the artery, life may be prolonged for a considerable period. In fact, the symptoms referred to the disease have been observed to last for years. It is not impossible that in some such cases a dissecting aneurism may pass into a common 'false aneurism.'

The position of the original rent seems always to be in the aorta, and generally in the arch, quite close to its origin, though it has been known to be situated in the abdominal aorta, even as low as its bifurcation. The position of the secondary rupture of the inner coats, by which the blood passes back into the cavity of the vessel, varies much. A case is mentioned in which the separation extended into the popliteal artery; and in another case, in which the primary rent was in the transverse arch, the secondary opening was in the subclavian.

Death occurs soon in all cases where the blood passes out of the artery, either into the pericardium or into the surrounding tissues; and in most of those in which the blood makes its way back into the artery. But in the few instances of the latter class in which life has been protracted for years, the unnatural channel running along by the side of the natural artery is lined by a smooth membrane resembling epithelium, and thus simulates a double vessel.

The symptoms of dissecting aneurism are best illustrated by a very interesting

¹ *Bull. de la Soc. de Chir. de Paris*, 1866.

² *Gaz. des Hôp.* 1868, pp. 117, 126.

³ *New Syd. Soc. Biennial Retrospect*, 1865-6, p. 303.

⁴ *Contributions to the Pathology of the Heart and Arteries*, 'On Dissecting Aneurism.' Edinb. 1849. *Path. Trans.* vol. xiv. p. 87.

case reported by Dr. Swayne and Mr. Keyworth of York,¹ in which the diagnosis was accurately made during life, and confirmed by dissection.

In that case, a man aged fifty-one, who had suffered for some time under symptoms referred to diseased heart, with aortic regurgitation (to which diagnosis one of his medical attendants, Dr. Latham, had added disease of the aorta), was seized suddenly one evening, as he was returning from a day of some exertion and excitement, with a very severe tearing pain in the chest, instantly followed by a second agonising pain, which seemed to dart from mid-sternum down the left of the spinal column, and only to be arrested a few fingers'-breadth below and to the left of the umbilicus, at which point of arrest, the patient thought he heard a distinct crack. He lost power in both lower extremities almost immediately, and the pulse became imperceptible in all the arteries of the lower limbs. A bellows murmur was heard below and to the left of the umbilicus. The 'tearing' pain recurred, and he then passed into a state of syncope, followed by great exhaustion and distress. Reaction set in next day, with much congestion, greatly relieved by bleeding. He survived about three months, dying of dropsy and hydrothorax. The pulse had recurred feebly in the right femoral artery before death. The diagnosis of dissecting aneurism, originating near the root of the aorta and passing down so far as to compress the true channel of the vessel near its bifurcation, was made at the time of the seizure and confirmed by dissection. A transverse rent was found in the arch of the aorta, just below its three large branches; a clot of blood was impacted near the bifurcation of the artery, obstructing the left common iliac completely and the right partially. The old canal of the aorta seems to have been disused, and the arteries to have communicated with the new channel.²

This case will serve to illustrate the usual run of the cases of dissecting aneurisms, though it is rare for the symptoms to be so well marked or so well observed; and therefore the disease is seldom recognised or even guessed at during life. The patient is usually advanced in life, very probably a female, and suffering from hypertrophy or other disease of the heart. The first symptom is a lancinating pain in the chest, corresponding to the seat of rupture, and this is generally followed by syncope and perhaps by pain at the part where the blood re-enters the artery, or where the tumour ceases. The pulse in the old channel of the artery may cease in consequence of the impaction of clot, aided by the pressure of the blood in the unnatural channel. This stoppage of the pulse of course causes more or less complete loss of power. In other cases, where the rupture occurs near the heart and the blood falls back into the pericardium, death is sudden. I can add nothing as to the diagnosis of the disease which may not be gathered from the symptoms in the above case. The only case in which I can conceive such an affection becoming the subject of surgical diagnosis, is where loss of power, loss of pulse, and threatening gangrene follow on dissecting aneurism; in which case the diagnosis would lie between this disease and embolism from the more ordinary causes of impacted clot.

GENERAL OBSERVATIONS ON THE LIGATURE OF ARTERIES.

It is in operations for the ligature of arteries that the proceedings of the operating theatre most nearly resemble those of the dissecting room; and it is in these operations, more than in any others, that minute anatomical knowledge is advantageous. Before undertaking to tie an artery, the surgeon ought to know its general course and its relations, and especially the prominent part or parts which are to guide him to the position of the vessel (to serve as rallying points, as the French operators say); he ought to have familiarised himself by frequent dissection³ with the thickness of the parts covering it, and their appearance, as far as that can be judged of on the dead body; and, finally, he ought to know the usual position of its principal branches, and the anastomoses by which the circulation may be expected to be restored. It is advisable also to be aware of the leading peculiarities in course,

¹ *Path. Soc. Trans.* vol. vii. p. 106.

² In this case, Dr. Swayne, after having his attention specially drawn to the fact by Dr. Peacock, distinctly asserts that the extravasation was *between* the external and middle coats.

³ So experienced an operator as Sir P. Crampton relates, that before tying the common iliac artery he practised the operation seven times on the dead subject, and says that each time he did so he learned something towards the satisfactory performance of the operation.

relations, bifurcation, &c., which the operator may perhaps meet with, and for which he ought to be prepared.

Having all these anatomical details clearly present to his mind, and being familiar with the various methods by which the vessel can be reached, the surgeon will be prepared to adopt that method which seems to him best suited to the case which he happens to have before him. It is better, if possible, to avoid the part of an artery where large branches are known to come off, since in such cases the clot that should form in the vessel during the process of its severance will be absent between the ligature and the opening of that branch; though this point is of less importance when animal ligatures are used, since the vessel will very probably remain undivided.

In dissecting down upon an artery, it is important to have a clear view of each successive structure as it is exposed; and therefore bleeding from any small veins or arteries that may be divided in the superficial incision should be at once restrained by ligature, torsion, or pressure. No attempt should be made to hurry over the proceedings; but as each layer of tissue is divided, the one below should be carefully examined with the eye and finger. Most large arteries run in a sheath of fascia, which also contains their accompanying vein. When the level of this sheath is reached, great care must be taken in applying the knife. The cellular membrane or muscles over the sheath having been properly divided or drawn aside, that structure itself should be cleaned by scratching with the finger, assisted by the blunt point of a director or silver knife. When the sheath has been fairly exposed, and the beating of the artery can be plainly felt through it, a small part of the membrane should be raised by the forceps and divided with the knife held horizontally, as is done in opening the sac of a strangulated hernia. The small hole over the artery must be extended with the point of the director or aneurism needle,¹ till a little channel has been made round the vessel, through which the thread can be carried easily. Great care is necessary to use the instruments with all gentleness at this stage of the proceeding, on account of the proximity of the vein. The needle is to be passed under the artery, in a direction away from the vein; *i.e.* the point of the needle is first passed between the artery and vein, and brought out on the side of the artery away from the vein.² When the needle has been passed under the artery, the latter should be compressed between the point of the finger and the curve of the needle, in order to see that the beating in the tumour is completely stopped, or the bleeding completely commanded; and to judge also by the feeling that no other structure has been taken up with the vessel. This is the more necessary in cases where the artery, as in the case of the subclavian, lies very deeply, perhaps out of sight, and touching a large nerve or other important structure.

Material of ligature.—As stated on page 51, the researches of Dr. Jones proved clearly that the best form of ligature is a single thread; that the large exposure of the artery which is required if a number of loose ligatures, or a broad tape, are employed, is very dangerous, as predisposing to secondary hæmorrhage, endangering the vein, and altogether complicating the case unnecessarily. But, although all surgeons now use a single thread, they do not all use the same material. Carbolised catgut was introduced into practice by Mr. Lister, and it seems to me a very great improvement on the old silk or hempen ligature. The latter necessarily involves ulceration, causing the complete division of the artery, and thus exposing the patient to the risk of secondary hæmorrhage, while with the catgut ligature there is not necessarily any division of the artery. Arteries so tied have been found afterwards without any trace of division of their external coat, though obliterated at the point of ligature.³

¹ Mr. Syme, however, whose experience in tying arteries was perhaps more extensive and more favourable than that of any other surgeon of his time, preferred cleaning the artery with the edge of the knife, using it till the whitish coat of the artery is clearly seen. If this plan is adopted, great care must be taken in scratching the vessel; and perhaps it will be well to blunt the edge of the knife a little.

² Further directions as to tying arteries for a wound will be found in vol. i. pp. 368–370.

³ The first case, I believe, in which this fact was absolutely proved by dissection was the one which I published in the *St. George's Hospital Reports*, vol. vi. Similar cases have since been described by Mr. J. R. Lane, *Brit. Med. Journ.* Nov. 10, 1877, and by Mr. Treves and Mr. McCarthy, *Mcd.-Chir. Proceedings*, vol. ix.

But experience has shown that the catgut ligature does not always act uniformly. In some cases, the pulsation in the aneurism has recurred so soon after the operation as to justify the belief that the knot has come untied; in others the ligature seems to have softened and so become loose. In either case, secondary hæmorrhage is very probable.¹ It is quite true that these cases are exceptional, and my own belief is that the carbolised catgut is much safer than the silk or hempen ligature. Still the occurrence of such accidents has led some surgeons to abandon the use of catgut for the ligature of arteries in their continuity, while retaining it for vessels tied in ordinary operations. Others have sought to improve the preparation of the catgut, and Mr. Lister believes that preparing the catgut in chromic acid will obviate such misfortunes in future.² Others, and with much apparent reason, have argued that a material prepared, as catgut is, by a rough and uncertain process of partial putrefaction, cannot be absolutely trustworthy, and that if some natural tissue could be properly prepared for use as a ligature, the desired end would probably be attained.³ For this purpose Mr. Barwell has used the middle coat of the aorta of an ox, cut into strips, stretched (in order to deprive it of its superfluous elasticity), and then kept in carbolised gauze. It is steeped in a solution of carbolic acid for a short time before use, and then becomes perfectly pliable. I have used this ligature myself with great success,⁴ and several cases of its successful use are quoted in Mr. Barwell's work on Aneurism.

Another and a very good animal ligature is that made from the small tendons of the kangaroo's tail. This has the advantage over Mr. Barwell's ligature of requiring no previous preparation. It is preserved in carbolised oil, and, when wanted for use, is wiped dry, and then steeped for a short time in weak carbolic lotion. This ligature has been used both at St. George's Hospital and elsewhere with much success, and appears to me to possess every quality which an animal ligature for the deligation of large vessels in their continuity should have.⁵ These ligatures are of course too large and too slippery to be available for securing the cut ends of arteries.

Another important question which is raised by the use of these animal ligatures is, whether the division of the two internal coats of the artery which is always (more or less completely) produced by the silk ligature is necessary or desirable. Mr. Barwell teaches that the two inner coats of the vessel had better not be divided, and he believes that by drawing the flat ox-aorta ligature only just tight enough to stop the pulsation, this end may be secured. On the other hand, many observers are inclined to the belief that the catgut ligature, sometimes, at any rate, fails in consequence of not producing enough irritation in the tissues of the vessel, so that no lymph is effused, and only a very weak barrier is set up in the tube, formed chiefly of the incurved inner coats. If these coats are not lacerated, it is probable that no lymph will unite their opposed surfaces, and hence there will be a chance of the barrier yielding to the force of the circulation. However this may be with the catgut ligature, which is soluble, and of which no trace is usually left after a short time, it is very possible that it may be otherwise with the ox-aorta or tendon-ligature, which probably do not disappear at all, or not until their place has been occupied by newly-formed tissue.⁶ It is therefore probable enough that Mr. Barwell's view may be correct; but it cannot be said to be proved as yet, and I confess that I have always felt safer in drawing the ligature as tight as possible. This necessarily involves, if not the complete division, at any rate more or less rupture of the middle and inner coats, as experiment on the dead body will show.

The external incisions.—Opinions differ as to the direction in which the incisions may be most advantageously made. Most operators make their incisions in the

¹ See Holden's case, *St. Barth's Hosp. Reports*, vol. viii. p. 187.

² *Lancet*, Feb. 5, 1881.

³ Barwell, *Med.-Chir. Trans.* vol. lxii. p. 403.

⁴ *St. George's Hospital Reports*, vol. x. p. 483.

⁵ See Dent, *Med.-Chir. Trans.* vol. lxiv.; T. Smith, at Med.-Chir. Soc., *Brit. Med. Journ.*, Feb. 18, 1882. I recently saw my colleague, Mr. Pick, use this kangaroo-tendon in a very successful case of ligature of the femoral artery.

⁶ Mr. Dent's paper, above referred to, contains drawings of such tissue in the course of formation in the substance of the tendon-ligature.

course which the vessels are known to pursue ; others prefer an incision which crosses obliquely the course of the vessel. The former plan enables the operator more clearly to anticipate and recognise the structures successively exposed ; the latter renders him more certain not to miss the vessel altogether, and also enables him more conveniently to investigate the parts around, should any anomaly, such as a high bifurcation of the brachial or femoral artery, render it necessary to search about, without any definite anatomical guide, for a vessel not usually present.

Large arteries ought not to be tied unless a reasonable probability exists of the recovery of the patient from an operation which must always be grave ; but, if the disease or injury admits of no other cure, nothing need be held to be a formal contra-indication to the operation ; not disease of the viscera, not disease of the heart, not even disease of the artery itself, although it must be allowed that the latter complication renders the case almost hopeless.¹ But, on the other hand, the most mature consideration is requisite to assure the surgeon that the case is really beyond the reach of other and milder measures. So much has lately been done to diminish the percentage of cases of aneurism which require ligature, that it may now be said that the presumption in a case of surgical aneurism is rather that it is curable without operation than that an artery will require ligature. It will be my object in the following remarks upon each particular form of surgical aneurism, to point out in what cases milder measures may be expected to succeed ; and when these fail, by what operations the affected arteries or the trunk above them can be reached ; and in treating of each form, I shall observe the same order as is followed in the essay on AMPUTATION, taking the upper limb first, with the head and neck, and proceeding from the extremity towards the trunk.²

ANEURISMS IN THE FOREARM AND HAND.

Aneurisms diminish in frequency as the vessels diminish in size ; hence the disease is very rare in the forearm and hand ; indeed, is hardly ever seen except as the result of accident, or in cases of extensive disease of the heart and arteries. In 1873 I collected partly from a paper by Mr. Spanton ('*Med. Times and Gaz.*,' 1865, vol. i. p. 517) a list of thirteen cases of spontaneous aneurism of the arteries of the forearm and hand, one of which is the more remarkable as occurring in an infant only eight weeks old. In the majority of the cases disease of the heart existed.³

There is generally not much difficulty in diagnosing an aneurism in the hand or forearm, nor in determining whether it be simply arterial or arterio-venous. The treatment of spontaneous aneurism of these arteries would be exceedingly simple if the disease could be found in a subject otherwise healthy. Digital or instrumental pressure on the artery leading to the aneurism will usually succeed with or without Esmarch's bandage. If this fail, recourse would be had to the Hunterian operation, and even in the last resort the old operation would present no great difficulty. I have performed it with great ease and success in a small traumatic aneurism of the superficial palmar arch. A case is referred to on p. 45 (note 2), where a small aneurism in the palm was successfully extirpated by chloride of zinc.

The arteries of the forearm far more often require ligature on account of a wound. It is hardly necessary to give minute directions for the performance of such

¹ If the artery on which the operation is performed be found, when exposed, to be extensively diseased, four courses are open. In aneurisms of the extremities, the safest course would be to amputate ; in a few cases the surgeon might resort to acupressure ; usually, the operation would be completed ; while sometimes the case would be abandoned to nature. Under the head of 'Ligature of the Innominate,' a remarkable instance of the good result of the latter course will be mentioned. The surgeon must rely upon his own judgment.

² In speaking of the ligature of arteries, it has been found impossible to separate the cases in which such operations are required for aneurism and for injury ; but as the former class of cases is by far the larger, it was judged best to include the description of all the operations in the present essay.

³ See a lecture at the College of Surgeons, reported in the *Lancet*, Oct. 25, 1873.

operations as tying the ulnar or radial near the wrist. Common sense would suggest to keep the tendons intact; and this being done, and care taken to avoid mistaking a nerve or piece of fascia for the artery, all the cautions necessary for the operation are exhausted. It is a matter almost of indifference whether the venæ comites are included in the ligature or not, though a careful operator would prefer to avoid them.

If the skin is unbroken, as when the radial or ulnar, or both, are tied for a wound in the palm of the hand, it is merely necessary to make an incision, from an inch to two inches in length, between the tendons which accompany the vessel, divide the deep fascia, which is often strengthened by a distinct thin layer over the ulnar artery; and if the tendon of the flexor carpi ulnaris overlaps the vessel (as is usually the case), draw it inwards, and then the vessel will be exposed by a little dissection enclosed in its sheath—the radial accompanied merely by a small filament of nerve lying above the fascia, which probably will not be seen, the ulnar having its nerve on its inner side.

The radial can be exposed, if necessary, higher up, by a similar operation; but now the muscular belly of the supinator longus requires to be drawn outwards, and the position at which the radial nerve lies against the artery (on its outer side in the middle third of the forearm) must be remembered. The different directions of the fibres of the supinator longus and pronator teres must be borne in mind. Their vertical direction will always distinguish those of the former muscle.

Ligature of the ulnar artery near its origin is a much more difficult operation. It is only required, as far as I know, in cases of wound. The very commencement of the artery may be exposed after the division of the bicipital aponeurosis, without cutting through any muscular fibres; but the depth of the parts is very considerable, and where there is much effusion of blood, it is by no means easy to recognise the wounded vessel, which may be the humeral itself, or either of its branches. In the only case where I ever saw this operation attempted, it was given up and the arm amputated. On examination it turned out that all three arteries were injured, the bifurcation of the main trunk having been cut across. To tie the artery a little lower down, Mr. Guthrie¹ recommends that an incision should be made through the aponeurosis of the biceps, the pronator teres exposed and drawn towards the ulna, and the dissection continued till the median nerve is brought into view, crossing the artery from without inwards. Then, if it is necessary in order to reach the vessel, part or the whole of the pronator teres is to be divided. In other cases it may be more convenient to divide the muscles from below, an incision being made from the point at which the muscular and tendinous portions of the flexor carpi ulnaris are felt to join, upwards for four inches, and the sheath exposed as the vessels emerge from beneath the flexor sublimis digitorum. If the wound be higher up, the division of the latter muscle, and even of those adjoining it, if it be necessary, may be pursued from this point. More or less loss of power will probably follow the division of the muscles, especially if extensive; but this is likely to be transient, and if not, it is a less evil than the loss of the hand. The nerve will probably be the first of the structures around the artery which comes into view. In cases of difficulty Esmarch's bandage will greatly facilitate the dissection of the wounded artery.

At the bend of the elbow aneurismal swellings are almost always traumatic, and generally are of the arterio-venous class. If the disease be a simple arterial aneurism, whether traumatic or spontaneous, pressure upon the brachial artery is the first resource of the surgeon. Acute flexion of the limb will very probably succeed, either by itself or as an accessory to the indirect compression. If these means should fail, the natural course, irrespective of any special complication, will be to tie the brachial artery. The treatment of arterio-venous aneurism has been discussed above (pp. 91–93); we need not, therefore, detain the reader on the diagnosis or treatment of aneurism at the bend of the elbow; nor does that of aneurism in the arm call for any further remark. We have, then, only to describe the operation on the brachial artery, which may be required for these affections.

¹ *Commentaries*, p. 294.

Ligature of the brachial artery for aneurism, or for wound of the lower part of the limb in which the wounded artery cannot be secured, is thus performed. An incision is made, about three inches in length, along the inner margin of the biceps muscle in the middle of the arm; or if that muscle be obscured by œdema, fat, or imperfect muscularity, then in a line drawn from midway between the two flaps of the axilla to the middle of the bend of the elbow. In making this incision, perhaps the basilic vein will be seen, and should be avoided. The fascia having been divided upon a director, the operator comes down immediately to the packet of vessels and nerves. The internal cutaneous and ulnar nerve lie to the inner side of the artery, and may or may not come into view; or perhaps the external cutaneous will be seen on the other side of the vessels. The difficulty of the operation (which is sometimes considerable) consists in recognising and isolating the artery. What renders this more troublesome is, that the artery, besides being closely surrounded with other structures, does not always maintain the same relation to them. The median nerve is more commonly above the artery, and is the first cord seen below the fascia; but occasionally it will be found under the artery. Again, the brachial artery may not be the only vessel which requires ligature, since another considerable vessel may exist in the neighbourhood (probably a radial artery given off high up, or a vas aberrans), which will have to be sought; ¹ it is, however, usually found close to the one first exposed. The veins often encircle the artery with an intricate plexus of anastomosing branches; hence the operation is frequently far less easy than the superficial position of the vessel would seem at first sight to promise. It is true that a little patience and anatomical knowledge will dispose of these difficulties; but they should not be forgotten in deciding the question of treating an arterio-venous aneurism at the bend of the elbow, since, besides the other objections to the Hunterian ligature, it may be said that, as an operation, it will very likely be found no easier, and perhaps much more difficult, than the old operation.

Ligature of the brachial artery is usually very successful, as far as the operation itself goes. It is true that in Porta's statistical table of six hundred cases of ligature of all arteries, ten out of sixty-eight cases of ligature of the brachial artery are said to have died; but in the absence of details we cannot tell whether they died from the effects of the operation. Gangrene is, however, believed to be sometimes a consequence of the application of a ligature to the upper part of the brachial artery, the anastomosis between its branches and those of the axillary being rather scanty (vol. i. p. 364).

AXILLARY ANEURISM.

Axillary aneurism, like popliteal, depends in a large proportion of cases upon injury, more or less severe, to the artery, in the violent movements of the joint near which it lies.² This injury may, as it seems, vary from complete rupture of the vessel to some slight contusion or strain, only appreciable by its results. In the former case the aneurism is of the consecutive, in the latter of the false, variety. So far there is little essential difference between axillary and popliteal aneurism. But the different anatomy of the parts occasions a great difference in the curability of these affections. The cellular space of the axilla is so loose and so large, that the tumour may attain a very unmanageable development before any treatment is called in. So that the great advantage which is always obtained in an aneurism by the condensation of the parts around the sac, and the commencement of spontaneous cure in the deposition of laminated fibrine, is less likely to occur in axillary than in other aneurisms; while the growth of the tumour, even if opposed by coagulum in one part, can easily go on in another. Further, in the treatment of axillary aneurism the Hunterian operation is less likely to be successful, since, instead of an artery pursuing a long and comparatively superficial course, without any considerable

¹ See the figure on p. 88.

² On the subject of subcutaneous laceration of the axillary artery, I would especially refer the reader to Mr. Callender's paper 'Respecting Rupture of the Axillary Artery in reducing Dislocations at the Shoulder-joint,' in vol. ii. of the *St. Bartholomew's Hospital Reports*.

branches, as the superficial femoral does, the vessel upon which the axillary aneurism is formed is short, deep, and so crowded with large branches, that a ligature can only be applied in close proximity to one or other of them.

It is often said that axillary aneurisms are more difficult to treat than others, because they are so often traumatic. But this seems to me a confusion of terms. A *traumatic aneurism* is more easy to treat than a spontaneous aneurism. What is meant is, that there is so often no aneurism at all, but only a lacerated artery; and a lacerated artery is not much more amenable to indirect methods of treatment than a wounded one. The presence or absence of a sac determines this point, and this fact is shown by the presence or absence of *pulsation*. I venture to think, with all possible deference to the great authority of Mr. Syme, that in his paper on the subject of axillary aneurism,¹ which gave a new impetus to the discussion of the very interesting question of the treatment of that affection, this point has hardly been made sufficiently plain to the reader, although it may have been present to the mind of the author. Mr. Syme begins his essay with the rather startling avowal that the doctrine, which he had been teaching for more than thirty years, of the superiority of the Hunterian operation to the old mode of treating aneurism, is questionable. But the instance upon which he supports this assertion is one in which, accurately speaking, there was no aneurism at all. The history of an accident, the presence of a large and increasing collection of blood, an arterial bruit, and no pulsation, afford as clear evidence of laceration of the artery, unaccompanied by the formation of an aneurismal sac, as can be obtained; and in such cases, whether they be in the axillary space or the popliteal, the Hunterian operation may be expected frequently to fail; and the only sure resource is to tie both ends of the bleeding vessel.² Still the situation of the injury will very much modify the treatment which would be recommended. In the popliteal space the old operation is very difficult and very fatal, while the Hunterian operation is easy. On this account, when the popliteal artery is ruptured, the ligature of the femoral artery has been practised, though unsuccessfully.³ Amputation is here usually the proper course. But in the axilla, the old operation has been found, in skilful hands, not more difficult than the ligature of the subclavian; it is possible that it may prove less fatal; and, if not fatal, it is certain to cure the disease, which ligature of the subclavian may fail to do. Hence, in a case of effusion of blood in the axilla from accident, where no indications of a sac exist, most surgeons would agree with Mr. Syme that the ligature of both ends of the injured vessel is a far more rational and more promising proceeding than the ligature of the subclavian, if either operation be requisite. But both are formidable operations, difficult to carry out satisfactorily, and even when performed in the most dexterous manner very dangerous to life. In spontaneous aneurism, or in traumatic aneurism properly so called, *i.e.* in tumours the outlines of which are well defined, the pulsation plainly perceptible, and which can be emptied by pressure if the circulation be commanded, what course should be pursued? Mr. Syme appears to be in favour here also of emptying the sac and tying the artery above and below it, and he performed the operation once successfully. Other surgeons would prefer to tie the subclavian, in spite of the great mortality with which that operation has been attended. Perhaps the decision will be best made according to the circumstances of the individual case. If the tumour extend far up, so that the clavicle is much raised, and the neck short and fat, the operation on the subclavian is so dangerous and so difficult that it would be better to operate on the aneurism. In contrary

¹ *Med.-Chir. Trans.* vol. xliii.

² 'We must not be led away,' says Mr. Erichsen, 'by the term *aneurism*, which has been applied to these cases, and not treat such a condition, resulting from wound or subcutaneous laceration, by the means that we employ with success in the management of that disease. In the diffused traumatic aneurism [which is Mr. Erichsen's term for a ruptured artery] there is no sac, properly speaking; and hence those changes to which a sac is necessary cannot take place. I doubt whether there is a case on record in which the Hunterian operation for aneurism, applied to the condition now under consideration, has not terminated in danger or death to the patient, and in disappointment to the surgeon.'—*Science and Art of Surgery*, i. 200.

³ See below, 'Ligature of the Popliteal Artery.'

circumstances (*i.e.* where the subclavian triangle is easily accessible and the aneurism buried deep in the axilla), the subclavian may be tied with good prospect of cure. The objection to the old operation, which rests on the probably diseased condition of the artery near the tumour, has less force in this situation than in the popliteal space; since in any case the ligature must be placed near the aneurism.¹ Cases are met with sometimes in practice (of which I exhibited a striking instance at the College of Surgeons²) in which the tumour has been allowed to grow to such a size that it would be hardly possible to treat it by the old operation, and the Hunterian ligature seems to hold out no hope of cure. In these desperate circumstances, if any treatment be undertaken, I should think it best to secure the subclavian, and then amputate at the shoulder-joint, tying all the vessels which might be found in and around the sac. The operation would no doubt be a formidable one, but no other chance, as far as I see, exists of saving the patient's life.

But would not all these affections, viz. ruptured artery, traumatic aneurism, and spontaneous aneurism, be found amenable to milder treatment if it were more perseveringly tried? It will strike the reader of many cases of axillary aneurism, in which the details are fully given, how well adapted they seem to have been for the treatment by digital pressure, had that method been known.³ At any rate, if moderate pressure on the artery where it crosses the first rib can be made (as it often can) by means of the finger or a pad, so as to control the circulation, the surgeon is not doing his duty to his patient if he expose him to the risk of a great operation without a careful and patient trial of this safe and often most successful method.⁴ Esmarch's bandage may also be used, or direct pressure made by a pad in the axilla. Instrumental compression is less easy on account of the shape of the parts, and is less likely to be well borne from proximity of the large nerves to the subclavian artery; but it might possibly be advisable to try it in the absence of a sufficient staff of assistants to make pressure with the fingers. If these means fail, one or the other of the operations above discussed must be performed.

Mr. Syme thus describes the operation which he performed in the case of ruptured axillary artery on which he first practised the *old operation*: 'Chloroform having been administered, I made an incision along the outer edge of the sterno-mastoid muscle, through the platysma myoides and fascia of the neck, so as to allow a finger to be pushed down to the situation where the subclavian artery issues from under the scalenus anticus, and lies upon the first rib. I then opened the tumour, when a tremendous gush of blood showed that the artery was not effectually compressed; but while I plugged the aperture with my hand, Mr. Lister, who assisted me, by a slight movement of his finger, which had been thrust deeply under the upper edge of the tumour and through the clots contained in it, at length succeeded in getting command of the vessel. I then laid the cavity freely open, and with both hands scooped out nearly seven pounds of coagulated blood, as was ascertained by measurement. The axillary artery

¹ On this head I would refer the reader to a very interesting case of axillary aneurism, too long to quote, by Dr. Morton, in the *Am. Journ. Med. Sc.* July, 1867, p. 70, in which the left subclavian artery was tied in its second part, between the scaleni; the tumour suppurated, hæmorrhage occurred on the forty-third day, and the limb became gangrenous; a vessel believed to be the subscapular was tied; the limb was removed at the line of demarcation; hæmorrhage recurred; and the stump was removed from the shoulder-joint successfully.

² *Lancet*, Sept. 27, 1873. Liston's case.

³ See a case described by Pelletan, *Clin. chir.* vol. ii. p. 50. 'By raising the shoulder slightly, the subclavian artery could be felt isolated; and by making even slight pressure with the finger, its pulsation and that of the entire tumour could be arrested.' So also in Mr. Crossing's case, in *Med.-Chir. Trans.* vol. xvi. p. 344, pressure on the artery as it crossed the rib was easily made; and the same may be said of Mayo's case, *ibid.* p. 360; and of Mr. Poland's in vol. lii. of the same *Transactions*. I merely instance these cases among many others to which the same remark applies. In my lectures at the College of Surgeons, on Aneurism, I referred to several cases of successful compression of the subclavian for axillary aneurism, one of which (Dr. Peatson's) furnished a preparation which is in the Museum of the College (see *Lancet*, Sept. 27, 1873).

⁴ Mr. Poland has related a case in which digital pressure was used with success in the treatment of a small aneurism of the subclavian artery (*Med.-Chir. Trans.* vol. lii.). Here, however, the artery rose much higher in the neck than usual, and was supported on a process of bone, possibly a cervical rib. The presence of such a rib would much facilitate the application of digital pressure to the subclavian artery.

appeared to have been torn across; and as the lower orifice still bled freely, I tied it in the first instance. I next cut through the lesser pectoral muscle, close up to the clavicle; and holding the upper end of the vessel between my finger and thumb, passed an aneurism-needle, so as to apply a ligature about half-an-inch above the orifice.¹

Mr. Syme adds the important remark, that the extreme elevation of the clavicle occasioned by the great effusion in the axilla, which rendered the artery so inaccessible from above, facilitated this proceeding from below. It was no doubt the same circumstance, of the great depth at which the third part of the subclavian was situated, which rendered it necessary to make an incision over it through the deep cervical fascia, before effectual pressure could be made on it; a precaution which ought to be taken in all similar cases.

Ligature of the axillary artery after the Hunterian method.—The axillary artery is sometimes, though rarely, the subject of operation for aneurism in the arm, the result usually of injury. This operation has been much decried, on the supposition that the necessary proximity of large branches to the ligature would surely lead to secondary hæmorrhage. We have, however, as above noted, the high authority of Mr. Guthrie, and others, for saying that this apprehension is exaggerated. The depth at which the artery lies, and the necessity for cutting through a mass of muscle to expose it, form another, but not a very powerful, objection to the operation, which seems, notwithstanding this, to have been often effected without much difficulty. Chamberlaine² tied the axillary artery just below the clavicle, by a horizontal incision parallel to the lower edge of the bone, commencing about three fingers' breadth from the sternal end of the bone, and terminating about an inch from the acromion. 'A second incision of about three inches in length was made obliquely through the integuments over the deltoid and pectoral muscles, meeting the first nearly in the centre. Then the clavicular origin of the pectoralis major was separated from the bone, and the artery brought into view by removing the fat and cellular membrane.' The only difficulty experienced was in passing the needle, in consequence of the depth of the cavity and the struggles of the patient. It was accomplished by passing an eyed probe under the vessel, the blunt end first, as I understand the account. The patient made a good recovery. Roux³ appears to have succeeded in tying the artery above the coracoid process, by an incision parallel to the course of the vessel, between the deltoid and pectoralis major, without dividing any muscular fibres; but his description is not very full. Most surgeons would think that the greater room and better view of the parts obtained by the division of the muscular fibres would be a great advantage, and would therefore prefer the former method.

In both these operations the artery is sought from above; an operation which Mr. Guthrie vehemently condemns.⁴ The operation which he proposes to substitute is one by which the artery is sought from below, which would of course be the preferable operation if the lower part of the artery (that below the pectoralis minor) is to be operated on, and by which Mr. Guthrie says that any part of the artery can be exposed, and the whole vessel traced up to the first rib, if required. An incision three inches long is to be made over the course of the artery upwards from the lower edge of the pectoralis major, and perpendicular to the course of its fibres. These having been divided, a full view of the axilla and its contents is obtained. If the operation is done for a wound, the bleeding mouth of the artery will be seen by relaxing (if necessary) the pressure which, in such a case, will have been put on the subclavian. Mr. Guthrie says that 'the finger introduced into the upper part of the wound would enable the operator to divide the pectoralis minor muscle if necessary, or to draw it upwards; when the artery, vein or veins, and the plexus of nerves, might be traced up to the first rib without difficulty.' Nevertheless, in any operation on this artery, the large vein which lies in front, and to the thoracic side

¹ *Med.-Chir. Trans.* vol. xliii. p. 141.

³ *Quarante Années, &c.* vol. ii. p. 133.

² *Ibid.* vol. vi. p. 128.

⁴ *Wounds and Injuries of Arteries*, p. 54. The reader may see a different process described (but only from operations on the dead subject) by M. Farabœuf. *Bulletin de la Soc. de Chir.*, 1880, p. 541.

of the vessel (sometimes, as Mr. Guthrie hints, double), the numerous large nerves which surround it, and the great quantity of branches which are given off from the artery, and which again give off large and numerous vessels towards the inner and front parts, where the operation must be conducted, will occasionally prove embarrassing to the most dexterous operator, though in other cases, as in those above referred to, the surgeon may have the good fortune to escape them.

Of the success of this operation, no sufficient data exist to enable us to judge ; it appears, however, both from published cases and *à priori* reasoning, that little danger of gangrene exists if the artery be tied above the origin of the sub-scapular, since that artery anastomoses so freely with branches of a higher origin (posterior and supra-scapular), that the blood is most readily conveyed around the ligature. Secondary hæmorrhage is more to be apprehended, and we may conjecture that diffuse suppuration in the loose cellular tissue of the axilla would often ensue.

I will not detain the reader with any remarks in this place upon the consequences of wounds of the trunk of the axillary artery, as distinguished from those which follow the division of one of its large branches near the trunk. The persistence of pulse at the wrist or in the brachial artery is the main feature in the diagnosis; the extent and the advance of extravasation of blood the circumstance which decides the necessity of cutting down on the wounded vessel.¹

Ligature of the subclavian artery in the third part of its course may be thus effected. The patient is to be laid down on the sound side ; the arm should be depressed as far as the tumour will allow, in order to draw the clavicle as much as possible out of the way of the artery ; the skin of the neck should be pulled down into the chest by the fingers of the operator's left hand, while he makes an incision down to the bone along the prominent part of the clavicle, from the edge of the sterno-mastoid to the trapezius. The skin is now allowed to retract, when the incision will lie above and parallel to the clavicle. In this way the external jugular vein, which here dips below the clavicle, will be avoided, and may be drawn with a blunt hook inwards or outwards (the former will generally be found more convenient) during the rest of the proceedings. If the muscles approach near to each other, the sterno-mastoid ought to be partly cut away from the clavicle.

If the patient be stout, or the clavicle much pushed upwards, so that the artery lies at a great depth, it is advisable to connect the transverse incision with one running upwards from its inner end, and dissect the flap outwards.² The cervical fascia must now be cautiously divided on a director to the extent of the wound, commencing from the outer edge of the sterno-mastoid, when the knife may be laid aside, and the parts separated by means of the finger, assisted by the point of a director or other blunt instrument. The finger of the operator is now passed into the 'subclavian triangle,' a small space bounded by the omohyoid muscle above, the clavicle below, and the sterno-mastoid at the inner side. Lying somewhat parallel to, but deeper than, the sterno-mastoid is the scalenus anticus muscle, which must always be carefully sought and traced down with the forefinger into the first rib. When the point of the finger is placed upon the ridge on which this muscle is inserted into the rib (and which terminates on the inner border of the bone, in a very perceptible tubercle), the artery will be felt immediately under the finger. The other structures contained in this triangle are two branches of the thyroid axis, the transverse cervical and supra-scapular, the veins accompanying them, which empty themselves into the external jugular, the brachial plexus of nerves, with some small branches, and finally an absorbent gland. If the transverse cervical artery should be divided, it will be tied without difficulty. The supra-scapular is usually below the clavicle, and is not seen. It did, however, come into view in Dr. Warren's case quoted below, and it was not without difficulty that he was enabled to avoid it ; which, as Dr. Warren remarks, it is

¹ See John Bell's *Surgery*, Charles Bell's ed. 1826, vol. i. p. 416.

² Or a flap may be formed by an angular incision projecting beyond the sterno-mastoid muscle, and this flap dissected inwards. (Skey, *Operative Surgery*, 1st ed. p. 220.)

important to do, both on account of the difficulty that might be experienced in securing it, and because it is an important agent in the collateral circulation. Should either of the veins, or even the external jugular, be much in the way, it may be tied with two ligatures and divided. The gland may be removed without scruple if necessary.¹ Much care is required to separate the artery from the lowest cord of the plexus, which lies so close to it that it often derives pulsation from the artery, and appears to be a part of it. This mistake is more liable to be committed when the artery is so deep as not to be easily brought into view. It is on this account that it is of so much consequence in these cases to keep the finger carefully on the anterior scalenus muscle, since the artery is more easily recognised by its position with respect to that tendon than by anything else.

This operation varies much in difficulty. On the dead subject, or in the living when the person is thin and the parts natural, nothing is more easy; on the contrary, when the clavicle is driven upwards, is greatly curved, as in persons accustomed to manual labour, and the patient stout and muscular, it is one of the most difficult of all the operations on arteries. In these latter circumstances, the artery lies at the bottom of a deep cavity liable to be filled with blood oozing from the many small vessels which will probably be divided in such a case, and the parts cannot be distinguished. It is not wonderful, therefore, that such operations occupy much time, and sometimes terminate in disaster. Two successive cases of Dupuytren's are on record;² in one of which everything went on favourably; while in the other the operation occupied an hour and forty-eight minutes, and on the death of the patient, four days afterwards, it was found that the ligature had been thrust through the vessel, and included one of the large nerves of the brachial plexus along with half the artery. In a case recently under my own care, fatal hæmorrhage was caused by clearing away the cellular tissue from the artery with the finger nail, preparatory to passing the ligature. Post-mortem examination proved that the sac, which extended beneath the clavicle, had given way before the operation, and the blood was only bounded by the thin cellular tissue which had thus been scratched through. Other cases are recorded in which the sac has been wounded. Another accident to which the operation is liable in complicated cases, is an injury of the pleura, or disturbance of the subserous cellular tissue which connects that membrane to the first and second parts of the subclavian artery. Thus, in a case of much difficulty operated on by Dr. Warren in America,³ the air rushing into the chest with a whistling sound gave evidence of the infliction of a wound on the pleura. The patient nevertheless recovered. Mr. Aston Key⁴ considers that pleurisy and the inflammation of the subserous cellular tissue leading to abscess in the anterior mediastinum will be found to be the most common causes of death in this operation—an opinion which the statistics of Norris and Porta go far to support; and points out the necessity that there is, on this account, for not meddling if possible with any part of the vessel except that which lies immediately on the rib, by which means such an injury to the serous membrane or subserous tissue will be avoided.

That ligature of the subclavian artery should be a very fatal operation, when performed for axillary aneurism, will surprise no one who considers the conditions under which it is performed. In the first place, the procedure resembles Anel's operation almost as much as Hunter's.⁵ Hence suppuration of the sac from loose formation of clot, and secondary hæmorrhage from disease of the artery, may be anticipated. Again, the ligature must be placed in the immediate vicinity of large branches. Then, again, the deficient formation of laminated clot is further favoured by the absence or loose structure of the aneurismal sac, and by the want of resistance

¹ See a case by Mr. Crossing, in *Med.-Chir. Trans.* vol. xvi. p. 340.

² See Quain's *Anatomy*, ed. 1848, vol. i. p. 504.

³ *Med.-Chir. Trans.* vol. xxix. p. 32.

⁴ *Med.-Chir. Trans.* vol. xiii. p. 8.

⁵ It differs indeed in principle from Anel's—so far as Anel's method can be said to have any principle; for as the aneurism may be seated below the acromio-thoracic artery, an anastomotic arch may continue the circulation through the sac after operation; but this cannot be calculated on.

in the parts which surround it (see p. 104). For these reasons the sound cure of the disease is less probable, and suppuration in the sac far more common in axillary than in other aneurisms; and if to these sources of danger those above noticed, which result from the anatomy of the parts, be added, we shall have, I think, a satisfactory explanation of the high mortality of the operation.

The statistics given by Norris, Porta, and others show a mortality of nearly one-half in operations for axillary aneurism. The value of such statistics, however, seems now much lessened by the introduction of new forms of ligature, and new plans of dressing wounds which have greatly reduced the danger of all these operations; but which have been in use too short a time to be as yet estimated arithmetically. The ligature of the subclavian, when practised on a healthy artery and far from the aneurism, as on Brasdor's method for innominate or aortic aneurism, seems an operation of little danger. But when practised for axillary aneurism often quite close to the sac, and on a vessel far from healthy, it must be an operation of much risk. When discussing this subject at the College of Surgeons in 1873 ('Lancet,' Sept. 27, 1873) I found that the mortality in recent cases had then been about the same as that shown in Norris's and Porta's tables, and I believe no more recent information has been collected.

I may be allowed to terminate this section by recapitulating the conclusions formulated in my lecture on Axillary Aneurism at the College of Surgeons.

1. There are a great number of these aneurisms, both traumatic and spontaneous, which are amenable to gradual intermitting pressure carefully applied to the artery above the tumour [and possibly Esmarch's bandage might in some cases be found serviceable].

2. Where this is not possible, from the pain produced by the pressure, the application of rapid total compression, under anæsthesia, may effect a cure.

3. The ligature of the subclavian artery is so dangerous both from its own risks and from the proximity of the sac that it ought to be restricted to cases where pressure has failed, and to those in which, from the size and rapid growth of the axillary tumour, the surgeon thinks pressure unadvisable.

4. The old operation is to be preferred to the ligature of the subclavian in cases of ruptured artery; and it may be practised in cases where, from the elevation of the shoulder or from the extent of the tumour, the surgeon would find it difficult to tie the subclavian, or fears, in doing so, to injure the sac; but the anatomical relations of axillary aneurisms render this a peculiarly hazardous proceeding, and the surgeon should always be prepared to amputate if necessary.

5. In very large axillary aneurisms, if any treatment be adopted, the arm should be amputated at the joint after ligature of the subclavian.

ANEURISM AT THE ROOT OF THE NECK.

This is one of the most formidable diseases which can occupy the attention of the surgeon; both the diagnosis and treatment are surrounded with difficulties that are often found insuperable. The main cause of this is the proximity of the heart. When there is a bruit it is exceedingly difficult to distinguish whether it is limited to the tumour, or is propagated into it from the cardiac valves; whether the pulsation is limited to the neck, or extends also into the thorax; and whether one only of the large vessels is implicated, or whether others of the great arteries in the neighbourhood, or the whole trunk leading from the heart, may not be diseased and dilated. Then in the treatment, the proximity of so great a stream of blood has hitherto prevented the successful application of a ligature upon the innominate or the first part of the subclavian, for the cure of aneurism situated above the axilla.¹ The atheromatous deposit, which generally, when it exists at all in these large arteries,

¹ Except in Dr. Smyth's case of ligature of the innominate, which will be referred to in the sequel, where the aneurism was probably traumatic, and possibly in Dr. Hobart's case, where the first part of the subclavian is said to have closed after ligature, as to which, however, I must allow that some doubt exists,

involves their whole calibre to a very great extent, has sometimes even prevented the surgeon from tying the artery after he has exposed it; and the probability of the existence of this state of the vessel renders it always a hazardous matter to attempt an operation.

First, as to diagnosis. The aneurismal nature of the swelling does not usually admit of any doubt; for though here, as elsewhere, malignant tumours springing from the bones may derive pulsation from their own vessels, or tumours of any kind from proximity to the arteries, such sources of ambiguity are less common than in other parts of the body. Reference may therefore be made, on the head of diagnosis between aneurismal and other tumours, to what has been said in the section on Diagnosis, and to what follows upon Abdominal Aneurism. But it is often a matter of great importance and of great difficulty to discover whether the aneurism involves the subclavian artery, or the root of the carotid, or the innominate, or more than one of these vessels, or the aorta by itself, or in conjunction with one of its branches. Mr. Wardrop¹ lays it down as a rule by which aneurisms of these several arteries may be diagnosed from each other, that when the disease affects the root of the carotid, it will present itself first in the small triangular space between the heads of the sterno-mastoid muscle; whereas when the innominate is the seat of disease, it will generally be found on the tracheal, and when the subclavian is affected, on the cervical, side of that muscle. These observations can, however, only apply to cases seen in the earliest period of the disease; and their deceptiveness even in such cases is shown by the fact, that out of the few cases cited by Mr. Wardrop, one² proved to be of the innominate artery, which ought, according to his rule, to have been of the subclavian. But though the place of the first external appearance of the aneurism is not decisive as to the part of the artery from which it springs, it is a symptom of considerable importance, and should always be carefully noted when it can be clearly ascertained. Another important symptom is the character of the pulsation in the branches of the carotid and subclavian. If the pulse in the brachial or radial, or that in the upper part of the carotid or the temporal, be materially less on the affected than on the sound side, we have some reason for believing the parent trunk (subclavian in one case, carotid in the other) to be affected; and in the opposite circumstances to be unaffected. But neither conclusion is free from some uncertainty. The growth of aneurisms in the cellular tissue of the mediastinum and root of the neck is so free, that instances have been observed of aneurisms of the arch of the aorta causing compression of the subclavian or carotid, without any disease of those vessels;³ while, on the other hand, if the aneurism approaches the tubular shape, the pulse may be unaffected in the branches, though the trunk is extensively diseased. Again, the influence of the anomalous distributions which so often affect the branches of the aorta is not to be forgotten.⁴ Possibly some assistance to the diagnosis may be obtained by a careful consideration of the other organs compressed by the tumour. Thus pressure on the great veins will lead to lividity, or even a permanently cyanotic condition of the extremity⁵ (hand and forearm, or face and scalp); pressure on the recurrent nerve, to laryngeal symptoms; on the phrenic nerve, to spasmodic action of the diaphragm; on the sympathetic nerve to irregularity of the pupil; on the trachea, to stridulous respiration, &c.; but much caution is necessary in estimating these symptoms, which are common to thoracic aneurisms as well as cervical.

¹ *Op. cit.* p. 83.

² Case of Gordon, *op. cit.* p. 104.

³ See cases by Allan Burns and A. Cooper, in Burns *On the Surgical Anatomy of the Head and Neck*, pp. 60 *et seq.* 1844.

⁴ I have seen a case in which, from other symptoms, there was no difficulty in diagnosing an aneurism of the arch of the aorta; but one circumstance was difficult to account for, viz. that while the pulse in the right carotid was unaffected, that in the right wrist was imperceptible. After death, that anomalous distribution was found in which the right subclavian is the last branch of the arch. Passing between the aneurism and the spine, it had been compressed, while the carotid was unaffected.

⁵ Wardrop, *op. cit.* p. 162; Ogle, in *Path. Soc. Trans.* vol. x. p. 103; Bellingham, *On Diseases of the Heart*, p. 601; Allan Burns, *op. cit.* p. 68. Barwell, *On Aneurism*.

Vertebral Aneurism.—I ought to refer here, though it must be in the briefest possible terms, to the occasional occurrence of traumatic aneurism seated on the vertebral artery. In lecturing on the subject of Aneurisms nearly ten years ago, I collected eleven cases of this affection,¹ and have not since met with any fresh instances, nor with the record of a spontaneous aneurism of this vessel. I can only find room here for the conclusions to which these cases seemed to me to point, and must refer for further details to the original lecture. '1. A traumatic aneurism may be taken to be vertebral, when it is situated in the course of that vessel, and when its pulsations are not commanded by compression of the lower part of the common carotid. 2. When a traumatic aneurism is situated as above, and its pulsations are commanded, however completely, by pressure on the common carotid low in the neck, it ought not to be treated as carotid or as affecting a branch of the carotid, unless it is clearly proved that its pulsations are stopped by pressure above the level at which the vertebral ceases to be compressible, *i.e.* above the level of Chassaignac's "carotid tubercle" [the anterior tubercle of the transverse process of the sixth cervical vertebra]. 3. An aneurism diagnosed as vertebral may be treated by compression (gradual or rapid, as the case demands) of the root of the vertebral artery in the neck, if this is found feasible. 4. If indirect compression will not stop the pulsation, or if it cannot be borne, the tumour should be subjected to direct compression and refrigeration, to which internal remedies may be added. 5. If these means fail, and the tumour seems likely to burst, or if it has burst, the sac should be opened, with all due precaution, and an attempt made to tie or plug the wounded artery. 6. A wound known or suspected to be of the vertebral artery should be treated either by direct pressure, or by ligature of the vessel in the wound.'

It will be seen from this extremely imperfect sketch, how difficult it is to determine, when an aneurism is situated low at the root of the neck, what or how great a part of the arterial tube is involved. The importance of a precise diagnosis consists in the fact that four great operations are recommended for such aneurisms, and that their applicability depends entirely on the limitation of the disease. 1. If the subclavian or carotid were alone involved, a ligature applied to the innominate artery would be analogous to the treatment adopted in other parts of the body. 2. If the aneurism were seated far down the subclavian on the right side, it might be possible to tie the first part of the artery itself, as indeed was done by Mr. Liston. 3. If the root of the carotid alone were implicated, a ligature on the distal side of the tumour (known as Brasdor's operation) might prove successful. 4. Aneurism affecting the innominate artery has often been treated with partial or entire success by distal ligature of the subclavian and carotid arteries, and this method has lately been extended to aortic aneurisms with results which at any rate are so far encouraging as to render it a duty to give the method a thorough trial.

Assuming that the question of performing any of these grave operations is not entertained till a patient trial of judicious medical and dietetic means has been made and failed, and that a thorough examination of the chest has given reasonable assurance of immunity from disease of the heart, lungs, and aorta, I will endeavour to state as succinctly as possible the conclusions to which I have been brought by observing a few cases, and reading the account of a good number.

1. The ligature of the innominate artery is an operation which has hitherto, except in a single case, only precipitated the fatal result impending over the disease, and which appears to afford less prospect of cure than the methods of general treatment which have been above indicated. But if these are obviously insufficient, it may in appropriate cases recommend itself to some surgeons.² It should never be performed, however, unless the artery can clearly be felt healthy behind the sterno-

¹ *Lancet*, July 26, 1873.

² See below, 'Ligature of the Innominate Artery.' Having regard to the successful issue of Dr. Smyth's case, it becomes a serious question whether the carotid and vertebral should not be secured in the same operation in which the innominate is tied. Further experience is necessary on this point. See Barwell, *On Aneurism*, p. 53.

clavicular joint;¹ or the tumour is so plainly limited as to afford a very reasonable hope that it will be found so. In cases of tubular enlargement of a long tract of artery in the neck, it is worse than useless to expose an artery which will probably be found so diseased as either to prevent the operator from the attempt to tie it, or to give way and occasion fatal bleeding within a few hours if it is tied.

2. The ligature of the first part of the right subclavian artery is an operation which cannot be described in more favourable terms than that of the innominate, as far as its results go; but the indications are, perhaps, rather less perplexing, since a clear space ought to exist between the tumour and the trachea. Viewing, however, the anatomical difficulties of the operation, the doubt that must always exist whether the artery will be found healthy enough to unite as firmly as is necessary to bear the impact of so great a column of blood, and the great liability to secondary hæmorrhage from the neighbourhood of large branches, the operation seems so unpromising that most surgeons would prefer the plan by manipulation devised by Sir W. Fergusson, or galvano-puncture, or the introduction of horse-hair, dangerous and uncertain as these measures must be allowed to be. If this operation be attempted, the surgeon should take into mature consideration the possibility of securing, at the same time, some of the large branches.

3. Brasdor's operation for securing the artery on the distal side of the tumour is applicable, and if applied strictly on the original idea of the operation, it would be applicable only, to aneurisms affecting the lower part of the common carotid artery; in which, from the equality of the radial pulse on the two sides, the distinct limitation of the tumour, the freedom from œdema of the arm and hand, and the absence of murmur in the aorta or subclavian, there is reason to believe that the affection is confined to the common carotid. In such cases, it would be reasonable to commence the treatment by applying digital pressure to the artery, in the position in which it is intended afterwards to tie it.

4. Brasdor's method has been lately used in two ways—*i.e.* the right carotid artery alone has been tied, in order to procure the obliteration of that part of the sac which previously transmitted the blood up that artery, or both the carotid and the third part of the subclavian have been simultaneously secured, on indications which to me at least are less clear, but which, if I understand rightly, aim at so far reducing the circulation through the whole tumour for some time after the operation as to allow of its complete consolidation. Both these operations have been practised not only in innominate aneurism, but in mixed innominate and aortic, and in pure aortic aneurism. And aneurisms of the transverse part of the arch have been treated (with much benefit in a few cases) by the distal ligature of the left carotid artery.

In the sections which describe the treatment of aneurism by manipulation, by coagulating injections, and by galvano-puncture, the reader will find sufficient data to guide him in forming an opinion as to the propriety of using those measures in any given case of aneurism in the neck.

Brasdor's method will be found described on a subsequent page, together with other operations on the common carotid artery. It remains only to describe the operations on the first part of the subclavian and on the innominate artery.

In order to secure the *first part of the right² subclavian artery*, as in the opera-

¹ If the shape of the bones or joints is altered, it is clear that the aneurism arises in the thorax.

² The left subclavian has been tied once in the first part of its course with a fatal result by Dr. J. K. Rodgers, of New York. The case will be found detailed in the *New York Journal of Medicine*, 1846. The artery was reached by turning up a large flap over the sterno-mastoid, dividing that muscle, except a portion of its clavicular attachment, reaching the inner edge of the scalenus anticus some distance above the rib (a point on which Dr. Rodgers lays much stress in order to avoid injury to the thoracic duct), and then following it down with the finger to its attachment. Thus the artery was reached, but a good deal of difficulty was experienced in getting the ligature round it, in consequence of its great depth, and the want of room, for the aneurismal sac lay very near. The patient died on the fifteenth day from secondary hæmorrhage. The ligature was found to have ulcerated through the vessel and lay loose in the wound. The cardiac end of the artery was firmly closed, but the

tion on the innominate, the root of the carotid is to be exposed and traced down to the bifurcation. The external incisions and superficial dissection are therefore the same for both operations. An incision should be made along the upper border of the clavicle, a director passed under the sternal border of the sterno-mastoid muscle, and the whole or the greater part of the muscle separated from the sternum and clavicle. An incision should also be made upwards along the inner edge of the muscle, and the whole flap containing the divided muscle should be reflected outwards. The sterno-hyoid and sterno-thyroid muscles now come into view, and may be drawn aside with a blunt hook, or cut across. This will expose fully the sheath of the carotid vessels—the internal jugular vein on this side inclining away from the artery, so as to leave an interval in which the pneumogastric nerve is to be found. If now the operator desires to secure the first portion of the subclavian, he must remember that the only part of it sufficiently free from important relations to admit of the operation is the small portion bounded by the pneumogastric nerve on the inner side, and the thyroid axis with the phrenic nerve on the outer side. The former nerve therefore is to be taken as the guide; and, the carotid artery having been traced down to the bifurcation of the vessels, the subclavian is to be followed outwards till the pneumo-gastric nerve is recognised by the finger. The ligature will then be most readily passed with a probe curved abruptly, or a needle more bent than usual, introduced from before backwards.

If, on the contrary, the *innominate* is to be tied, the operator must follow down the line of the carotid artery into the thorax, when he will find the end of the vessel behind the sterno-clavicular joint, and must get the ligature round it as best he can—perhaps the most difficult part of the whole operation, since great veins lie close to the artery, the slightest wound of which may give rise to fatal hæmorrhage, and the parts are probably quite out of sight.

The innominate has also been reached from the front, by removing the end of the sternum and the sternal end of the clavicle. Two cases were operated on after this manner by Dr. Cooper, of San Francisco,¹ the aneurism affecting in both cases the carotid and subclavian arteries, while in one at least the end of the innominate itself was diseased. The first patient died a few days after the operation, his death being hastened, it is said, by disease of one kidney. In the second case hæmorrhage had occurred, but the patient was going on well, when he tore off the bandages from his wound, with the intention of destroying himself, and perished of hæmorrhage on the thirty-fourth day.²

The innominate artery has now been tied more than a dozen times. Mr. Erichsen tabulates thirteen cases, including the last published case under the care of Smyth. M. Le Fort,³ who omits one of Mr. Erichsen's cases, adds two others said to have been operated on by Bugalsky, which Mr. Erichsen discredits. There is likewise another operation which is said to have been performed by Pirogoff, and all these cases are received by Dr. Pilz. If we

distal end was patulous and the vertebral and internal mammary branches were found to have come off just beyond the ligature, and were, no doubt, the channels through which the bleeding had come. Dr. Rodgers accordingly proposes to tie all accessible branches, if the operation be repeated. My own view is that this operation can only be expected to succeed if the artery can be tied with a ligature which will not divide it. In Dr. Rodgers's case the pleura appears to have been lacerated. The internal jugular vein was also obliterated and filled with fibrinous coagula, whether from injury in the operation or compression by the tumour does not appear. The aneurism was found completely blocked up with coagula, and the axillary artery as it emerged from it was plugged with fibrinous clot. In the *Med.-Chir. Trans.* vol. lviii. is recorded a case in which Mr. MacGill of Leeds exposed the left subclavian in the first part of its course, and put a pair of torsion forceps on it for about ten hours. The pleura was opened, and the patient died apparently from the effects of this wound, after five and a half days. The aneurism lost all pulsation after the operation, and was found completely full of clot. This operation, together with that of Dr. Rodgers, shows that the prevalent idea of the inaccessibility of the first part of the left subclavian artery is erroneous; and the effect of Mr. MacGill's, as well as Dr. Rodgers's, operation on the aneurism is certainly encouraging for future operations on the proximal side of the aneurism.

¹ *Amer. Journ. of Med. Sci.* Oct. 1859.

² Erichsen, *Science and Art of Surgery*, vol. ii. p. 8.

³ *New Syd. Soc. Biennial Retrospect for 1865-6*, p. 351.

received all these as authentic, we should have sixteen or seventeen operations—one of which only proved successful.¹ In that case² the innominate and carotid were tied simultaneously by Dr. Smyth of New Orleans, for subclavian aneurism, referred to an injury received about three months before. Secondary hæmorrhage occurred fourteen days afterwards. The wound was then plugged with small shot and the ligature on the innominate was ‘pulled away, even against some resistance.’ The tendency to hæmorrhage was kept in check for more than a month by the compression of the shot, when it recurred with great violence. The vertebral artery was then tied. This was followed by marked decrease in the circulation of the arm and the brachial artery became occluded. The radial pulse, however, returned after a few days. All went well after this last operation, and the patient survived nearly eleven years. The aneurism however recurred, how long after the original operation is not quite clear; but its complete recurrence was not verified till ten years after the ligature of the innominate. A last desperate attempt was made to tie the vessels in the sac, but proved fatal from hæmorrhage. Dissection showed that the aneurism had been reproduced by a retrograde current through the subscapular.³

In four cases the artery has been exposed, but found so diseased that the operator has not dared to tie it. In one of these cases (Porter’s) the disease afterwards underwent a spontaneous cure.

A case is reported in vol. xix. of the ‘Bulletin de l’Académie Imp. de Méd.’ p. 454, in which M. Peixoto of Brazil, is said to have tied the innominate with a ‘ligature d’attente,’ removed on the twelfth day, for hæmorrhage from an erectile tumour of the ear, coming on before the separation of a ligature which had been placed on the common carotid. The patient recovered completely. There is no proof, however (as M. Velpeau, the reporter for the Academy, observes), either that the innominate was really tied in this case, since the ligature might have been placed under the root of the carotid, or, if tied, that it was obliterated.

Cases of temporary ligature of the innominate artery are recorded by Dr. Porter of Dublin⁴ and Mr. Bickersteth of Liverpool,⁵ but neither was successful, and I have no doubt that it is safer to tie the artery with a stout animal ligature.

The operation on the first part of the subclavian has been hitherto uniformly fatal. Eleven cases are on record;⁶ the cause of death was hæmorrhage in every case which survived long enough. In one (Mr. Partridge’s) the patient died on the fourth day, from pleurisy and pericarditis. If the surgeon should trust himself to perform this operation, it would undoubtedly be his duty, remembering Dr. Smyth’s and Mr. Liston’s cases, to endeavour to guard his patient from secondary hæmorrhage by tying the carotid and vertebral at the same time, and some form of animal ligature should be used. But it must always remain in the highest degree doubtful whether such an operation would not be more dangerous even than the disease it is intended to cure. Sir W. Fergusson has proposed to treat aneurism at the root of the neck which resists less heroic measures, by amputating at the shoulder-joint, trusting that the (distal) ligature of the axillary artery on the face of the stump would cure the aneurism now that the limb is removed, and so no need exists for a collateral circulation. This operation has been performed four times, by Mr. Spence, Mr. Holden, Mr. H. Smith, and Mr. Heath.⁷ All that can be said about it is that in Mr. Spence’s case the patient was thought to have been benefited by the operation, but

¹ As these sheets are passing through the press, I see a fresh case of ligature of the innominate reported, which was doing well at the date of the report, but this was only a few days after the operation.

² *New Syd. Soc. Biennial Retrospect for 1865–6*, p. 346; from the *New Orleans Med. Record*.

³ See a pamphlet by Dr. Smyth published at New Orleans, 1876, entitled *The Collateral Circulation in Aneurism. Report of the Successful Ligature of the Innominate, &c.* I have not space to discuss the theory of the collateral circulation which Dr. Smyth here puts forward. I can only say that it rests on the assumption that there is only one channel of collateral circulation after ligature, and that this assumption is contradicted by numberless dissections in which numerous channels have been unmistakably proved to exist. See figs. 6, 7, p. 52.

⁴ *Dublin Quarterly Journal*, Nov. 1867.

⁵ *Med.-Chir. Trans.* vol. lvi. p. 129.

⁶ Erichsen, *op. cit.* ii. 84. Hobart’s case is not reckoned in this list, and indeed I cannot say that it is quite free from doubt. The first part of the subclavian is said to have been tied, simultaneously with the carotid artery, for innominate aneurism. The patient died of hæmorrhage from the carotid, the subclavian artery having quite healed after the separation of the ligature. The parts have been preserved, but on getting them over from Ireland by the courtesy of the present Dr. Hobart, I was much disappointed to find that the subclavian artery had been cut away, so that no anatomical proof of so interesting a surgical fact remained. See *Lancet*, July 13, 1872.

⁷ See a paper by Mr. Heath, *Med.-Chir. Trans.* vol. lxxiii. p. 65,

that in none of the others did it do any good. In Mr. Spence's case, however, the limb was threatened with gangrene, and there the operation is no doubt justifiable. In any other circumstances, it seems (to say the best of it) highly dubious. In one case (referred to on p. 106, note 4) subclavian aneurism has been successfully treated by digital pressure above the tumour, but there were peculiar anatomical conditions in that case which cannot be expected to be again met with, and in a case of my own a small subclavian aneurism was treated with complete success by mechanical pressure.

Ligature of the *vertebral artery* was performed by Dr. Smyth, of New Orleans, for secondary hæmorrhage, in the case of ligature of the innominate and carotid above mentioned, and has lately been recommended by Dr. Alexander, of Liverpool, in epilepsy. The operation is performed in the following manner¹:—

The head of the patient being thrown backwards and turned slightly to the left, an incision two inches long was made from a little above the clavicle along the posterior border of the sterno-mastoid muscle. The edge of this muscle having been exposed and drawn aside, the prominent anterior tubercle of the transverse process of the sixth cervical vertebra was readily felt, and taken for a guide—the artery lying vertically below it. A layer of fascia was divided, some loose cellular tissue with lymphatics and the ascending cervical artery were pulled to the inner side; the scalenus anticus and longus colli muscle were separated from each other close below their insertion into the tubercle, when the artery and vein became visible. The vein was drawn to the outer side (a point of importance according to Dr. Smyth), and the needle was passed round the artery from without inwards. Dr. Smyth remarks that when the artery enters the foramen in the fifth transverse process, it is more readily found. In one case which he dissected he found it entering the foramen of the seventh vertebra. In Dr. Smyth's case the operation was much facilitated by the empty condition of the vessels consequent on the previous hæmorrhage.

Dr. Parker of New York also tied the vertebral artery simultaneously with the carotid and subclavian (its first part) in a case of subclavian aneurism. The patient died of hæmorrhage, and on post-mortem examination it was found that both the central end of the subclavian and that of the vertebral were opened by ulceration.²

BRASDOR'S METHOD OF TREATING ANEURISM.

Brasdor was, it is said, the first to propose the operation which has ever since gone by his name, viz. the ligature of an artery affected by aneurism on the distal side of the tumour, or that farthest from the heart, instead of the usual plan of tying it between the heart and the tumour. Brasdor, however, has left no written account of his proposition, nor did he ever put it in practice. It was renewed by Desault, and he has left us a notice of it in his works.³ The first person to act upon the suggestion was Deschamps, in a case of femoral aneurism; but his operation was undertaken on such mistaken principles, and was conducted so unsuccessfully, that little use can be made of it. Sir Astley Cooper⁴ tied the femoral artery below an aneurism in the groin, which appeared to him to have extended so far up as to render the application of a ligature above the tumour impracticable. It seems, however, from the terms in which this operation is spoken of, that it was only intended as a temporary expedient, and that Sir A. Cooper expected from it merely such a diminution in the size of the tumour as would render it afterwards possible to apply a ligature in the ordinary way. In this he was disappointed, for the tumour continued to extend upwards, and burst under the peritonæum.

With the resources that modern surgery possesses, and, it may be added, with the knowledge we now possess of the very grave dangers attending on ligature of the large vessels, such operations as those above alluded to would be universally repudiated. There is no such reasonable probability of curing an aneurism of any large artery of the limbs by distal ligature as would justify a surgeon in exposing his patient to the risk of the operation.

¹ This method of operating will be found described in Mott's *Velpeau*, vol. ii. p. 229.

² *Am. Med. Times*, March 5, 1864; *Am. Journ. Med. Sc.* 1864, p. 562.

³ *Œuvres chir.* vol. ii. p. 568.

⁴ Hodgson, *op. cit.* p. 301. Mr. James, of Exeter, performed a similar operation on the patient in whom he afterwards secured the aorta, and attributed to the distal ligature of the femoral a certain amount of diminution of the tumour (*Med.-Chir. Trans.* vol. xvi. p. 1).

There is, however, one situation in which the operation has been successfully performed, and in which it will be perfectly justifiable to repeat it, at least until some more certain and safe means of cure can be suggested; viz. in aneurisms of the carotid artery at the root of the neck. Mr. Wardrop¹ was the first to show the practicability of this proceeding; and he operated successfully on a carotid aneurism of recent origin in a lady aged seventy-five.² To him also must be conceded the merit of showing the difference in principle between the operation as practised upon the carotid and upon the arteries of the limbs. The difference depends simply upon the fact that no branches are given off by the carotid artery in any part of its course; so that, for this purpose, the whole of the vessel may be regarded as part of the aneurismal sac, and a barrier at any part of the artery will stop the circulation through the tumour. This at least is the case if the aneurism be not situated so near to the subclavian (on the right side) as to share in the circulation of that vessel; but such a tumour would be almost as much an aneurism of the subclavian as of the carotid. On account of his success in this instance, and his work written to recommend this form of operation,³ Mr. Wardrop's name is frequently associated with the method of distal ligature.

Wardrop pointed out plainly the difference in the method of Brasdor as applied to carotid and to other aneurisms—viz. that in the former no branch intervenes between the aneurism and the ligature; and he related four cases of carotid aneurism so treated, 'proving indisputably,' as he said, 'that the future growth of an aneurismal tumour may be arrested, and its parietes consolidated, by placing a ligature on an artery on the *distal* side of the sac, when no branch intervenes between the sac and the ligature' (*op. cit.* p. 53). He goes on from this point, which he believes himself to have demonstrated, and the demonstration of which is I think quite satisfactory, to state that in his opinion the same method may also be pursued in cases where the artery is differently situated, *i.e.* where branches do intervene between the aneurism of the ligature, as in the cases where the carotid artery alone, or the subclavian and carotid simultaneously, are tied for aneurism of the innominate. But here I cannot think Mr. Wardrop's facts or reasonings are at all conclusive. He gives one case (that of Mrs. Denmark) in which he tied the subclavian artery for innominate aneurism, the carotid being so compressed that he judged it to be impervious, which, however, it was not. The patient survived some time, and evidently derived benefit from the operation, but the disease seems not to have been really cured. Mr. Wardrop also mentions the case operated on by Mr. Evans of Belper, by ligature of the carotid alone, in which the symptoms of impaction of clot in the subclavian artery were very obvious (see below, pp. 120, 122).

In the 'American Journal of the Medical Sciences,' vol. xiv. p. 22, will be found a table by Dr. Norris of fifteen cases in which the carotid artery was tied on Brasdor's principle.⁴ Of these fifteen, four are admitted to have died of the immediate effects of the operation: and to this number the third case in the table⁵ ought certainly to be added, and perhaps the sixth also. At any rate, we shall probably not err much in representing the mortality of Brasdor's operation on the carotid artery at one-third of the number of cases. Of the fifteen cases, four only are said to have been cured by the operation. All of them appear to have been aneurisms of the carotid, unless one should be excepted (No. 5), in which the innominate was thought to be affected; but as this case recovered, the diagnosis was of course not

¹ *Med.-Chir. Trans.* vol. xiii. p. 217.

² I accept Wardrop's diagnosis of this case; yet it is possible that there may have been some mistake. Pulsation in the carotid at the root of the neck when the artery is somewhat lax and tortuous, often simulates aneurism when there is none (see Barwell, *On Aneurism*, p. 35, and my 'Lectures on Aneurism,' *Lancet*, June 14, 1873). I think I am not mistaken in saying that no preparation exists showing an aneurism limited to the root of the carotid artery on either side, though aneurisms have been found tolerably low down in the vessel, as in Scarpa's case referred to in the above lecture.

³ *On Aneurism*. London, 1828.

⁴ Of which six were for aneurism, supposed to affect the carotid only; in the remainder, the innominate was thought to be the seat of the disease, though it is plain, from the dissection of cases in which death took place, that in some at least the arch of the aorta was diseased.

⁵ Mr. Lambert's, quoted from Wardrop, *On Aneurism*.

absolutely confirmed.¹ Dr. C. Pilz has given a table of thirty-eight cases, in which, according to his classification, the carotid artery has been tied on Brasdor's method. The value of that table, however, will be found to be much diminished by the fact that Dr. Pilz has mixed together cases in which the ligature of the carotid was the main operation, and which were operated on strictly on the principles laid down by Wardrop, with others in which (as in Liston's and Smyth's cases) the main operation was the ligature of the trunk between the tumour and heart, and that of the carotid was merely a precaution against the reflux current. Nor is Dr. Pilz's collection by any means free from errors. Out of the thirty-eight cases, twelve only recovered, twenty-five died, and in one the issue was uncertain. A careful examination of Dr. Pilz's table will, I think, convince any person that the reality of cure or even of improvement in many of the twelve cases which recovered from the operation, is not only not proved, but is highly improbable. I refer especially to the cases marked 553, 559, 564, 566, 583, 586. If we take these statistics as being correct, which we are obliged to do in the want of more extended experience, it is abundantly plain that the risk of the operation is counterbalanced by a rational probability of success only when the aneurism is seated upon the carotid itself, and does not share in the pulsation of the subclavian. The above amount of success is, however, quite enough to justify the adoption of the method in any such case, where the attempt to tie the artery on Hunter's principle would be impracticable or even attended with unusual danger.

One circumstance, which seems to occur pretty generally though not universally in these cases, testifies very strongly to the activity of the efforts of nature to cure the disease. It is, that the pulsation in the tumour is usually not increased, but, on the contrary, often much diminished, by the ligature of the vessel beyond it. In almost all the cases related in Mr. Wardrop's book, the tumour was observed to diminish both in size and pulsation immediately after the operation; a result which could only have been due to the rapid increase in size of the branches below the tumour, by which the course of the stream of blood was diverted from the aneurism.

Aneurism of the innominate artery and other aneurisms at the root of the neck have also been treated by the distal ligature, sometimes of the carotid and subclavian simultaneously, at others of the same arteries with an interval between the two operations.

Mr. Fearn of Derby² tied the carotid on August 30, 1836, and the third part of the subclavian on August 2, 1838, on account of an aneurism of the innominate artery. The patient recovered from both operations, and died four months after the ligature of the subclavian, from a cause unconnected with the operation or the disease. I append a representation of the parts, which are preserved in the Museum of the Royal College of Surgeons (fig. 18).

It is impossible to doubt that in this case a cure temporarily at any rate has been produced by the operations employed. The doubt expressed on that point in the first edition of this work, resulted from a little ambiguity in the original description of the preparation. As the patient's death happened so soon after the apparent cure of the aneurism, it is impossible to speak with confidence as to the probability of a recurrence; such recurrence is of course always to be apprehended when a channel remains through the aneurism, and has been noticed after the apparent cure of the disease in many cases of cervical and other aneurisms. But this does not affect the main fact, which is, that the patient's symptoms were completely relieved; and especially (a point to which I would call particular attention) that the growth of the aneurism against the trachea was stopped. I think we are entitled to reckon Mr. Fearn's case, therefore, as one of cure.

Another and still more interesting case in which temporary cure resulted, was under the care of Mr. Christopher Heath, who tied the third part of the subclavian and the carotid artery, simultaneously, on November 21, 1865, for an aneurism believed to be innominate.³ The patient was a woman aged thirty. I have not space to describe the symptoms. It will be sufficient to say that she had had hæmoptysis, was greatly distressed by dyspnoea, and there was also some dysphagia. The diagnosis was a good deal debated at the time. Some surgeons thought the disease a pulsating cancerous tumour of the bones; many (and myself among the number) were rather inclined to believe it to be a tubular aneurism involving the aorta and innominate. Mr. Heath inclined to the belief that the affection was purely

¹ The last case operated on in London was under the care of Mr. Lane. The operation was unsuccessful, as the aneurism burst into the lung. After death the aneurism was found to involve the aorta as well as the carotid.—Cooper's *Surg. Dict.* 8th ed. 1861, vol. i. p. 215.

² Fearn, *Lancet*, 1836-7, vol. i. p. 129; 1837-8, vol. ii. p. 763; and 1838-9, vol. i. p. 437. See also *Path. Trans.* vol. xviii. p. 42.

³ See *Lancet*, January 5, 1867.

innominate. The operation was followed by great and evident relief to the breathing, and the tumour diminished in size, allowing a perforation which existed in the sternum, but had been previously imperceptible, to come into view. The patient survived the operation four years; but the tumour never ceased to pulsate, and she died ultimately of its rupture externally through an aperture in the upper part of the sternum involving the right sterno-clavicular joint.

The parts are in the Museum of the Royal College of Surgeons, and they show a bilocular aneurism of the aorta, the innominate being hardly if at all affected.¹

In this case the benefit from the operation, and the consequent prolongation of the patient's life, were too decided to admit of any doubt, and I think furnish abundant justification for the treatment employed, in spite of an error in diagnosis, which I believe to have been inevitable. The improvement obtained would no doubt have been more permanent had the patient's habits been different; but she was a woman of most irregular life, and after the operation had been brought in a state of intoxication into nearly every hospital and workhouse infirmary in her part of London. Here, as in Mr. Fearn's case, the relief of the dyspnoea is a very striking fact.

Still more striking is the success obtained by Mr. Barwell with the simultaneous double distal ligature, used in four cases for presumed innominate or mixed aneurism, and in the fifth for an aneurism correctly diagnosed as purely aortic. One patient died from the direct effects of the operation, but all the other four were greatly benefited. The patient with aortic aneurism survived fifteen months, and then died of the gradual progress of the disease. In the other three cases Mr. Barwell claims a cure, and we may fairly allow the claim in the same sense as in Mr. Fearn's case—*i.e.* the symptoms were relieved, and the sac so lined with clot as to be secure against rupture and to render renewed growth improbable.²

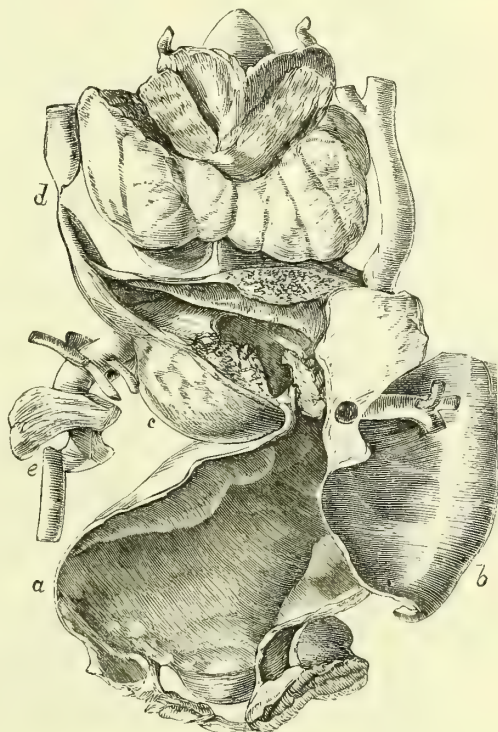
I append a statement of the cases of distal ligature, for aneurism of the aorta and its branches which I can find on record hitherto, in a tabular form.

I. DISTAL LIGATURE OF THE RIGHT CAROTID.

a. For aneurism of the right carotid.

1. Wardrop, 1825. Recovered. Wardrop, *On Aneurism*.³
2. Lambert, 1826. Died. Wardrop, *ibid*.
3. Bush, 1827. Recovered. Wardrop, *ibid*.

FIG. 18.—The parts from the case in which Mr. Fearn, of Derby, tied the carotid and subclavian arteries for innominate Aneurism. (From the preparation in the Museum of the Royal College of Surgeons.)



a, the root of the aorta; *b*, the dilated portion of the arch divided. A portion of the inner wall of the artery is seen above, in a different light, with the left subclavian artery opening out of it; *c*, the aneurism occupying the whole length of the innominate artery, almost entirely filled with firm coagulum, through which, however, a channel is left about equal to that of the natural artery. A portion of clot is seen projecting through the mouth of the aneurism into the aorta; *d, e*, the carotid and subclavian arteries at the seat of ligature.

¹ *Path. Soc. Trans.* vol. xxi. p. 132.

² See the dissection of one of these cases and the reports of the others in Barwell, *On Aneurism*, or *Med.-Chir. Trans.* vols. lxi., lxii.

³ Wardrop claims to have tied the carotid in a second case of this nature, but as the artery was found completely pervious after death, and with no trace of ligature, it is probable that a mistake was made in the operation. The case is therefore not reckoned here.

4. Lane, 1852. Died. Art. 'Aneurism,' Cooper's *Surg. Dict.* 8th edition, vol. i. p. 215.
5. J. R. Wood, 1840. Recovered. Aneurism cured. *New York Med. Journ.* 1857, p. 20.

b. For aneurism of the innominate.

1. Evans, 1828. Recovered. Wardrop, *On Aneurism*.
2. Mott, 1829. Died seven months afterwards. Mott's *Velpeau*.
3. Aston Key, 1830. Died in a few hours. *Med. Gaz.* vol. vi. Guthrie, *On Arteries*.
4. Case reported by Neumeister, 1830. Died five days afterwards. Hollond, *Dublin Quarterly Journal*, February 1852.
5. Morrison, 1822. Died one year and eight months afterwards. *Am. Journ. Med. Sc.* vol. xix. p. 329.
6. John Scott. Died. *Lancet*, 1834-5, vol. i. p. 893.
7. Dohlhoff, 1837. Died sixth day. Broca, *On Aneurism*, p. 632. *Rust. Mag.* 1838, vol. ii. p. 539.
8. Fergusson, 1841. Died seven days afterwards. *Lond. and Edin. Journ.* 1841, vol. i. p. 786.
9. Porta, 1842. Died forty hours afterwards. Porta, *Alt. patol. delle Art.* p. 35.
10. Hutton, 1842. Died sixty-six days afterwards. *Dublin Journal*, vol. xxv. p. 499.
11. Vilardebo, 1843 (?) Died twenty-one days afterwards. *Arch. gén. de Méd.* 1847, p. 547.
12. Campbell, 1844. Died nineteenth day. *Lond. and Edin. Journ.* 1845.
13. Wright, 1855. Died sixty days afterwards. *Montreal Med. Chron.* April 1856.
14. Ordile of Naples. Died.¹
15. Addinel Hewson, 1867. Died twelve days afterwards. *Pennsylvania Hospital Reports*, vol. i. 1868.
16. Pirogoff, 1864 (?) Recovered from the operation. Improved two and a half months afterwards. Pirogoff, *Allg. Kriegschirurgie*, 1864, p. 457-8.
17. V. Mott, 1820. Death from hæmorrhage. Twentieth day. Wyeth, *op. cit.* case liii.
18. Nussbaum (?) Death from progress of aneurism. *Ibid.* case liv.
19. Hutchinson of Brooklyn, 1866. Died from growth of aneurism on the sixty-first day. An attempt made to tie the subclavian simultaneously, see Wyeth, case xliii.

c. For aortic aneurism.

1. Annandale. Recovered with improvement. *Brit. Med. Journ.* Oct. 30, 1875.
2. Bryant. Died ten days. *Ibid.* Feb. 17, 1877.
3. Holmes, 1877. Died two days. The disease extended very high in the neck. The common carotid was inaccessible. The internal carotid was tied and by mistake the internal jugular vein was tied instead of the external carotid artery. The vein had been quite lifted out of its place, and shared the pulsation of the tumour. *St. George's Hospital Reports*, 1877.

II. DISTAL LIGATURE OF LEFT CAROTID.

a. For aneurism believed to be of the carotid itself.

1. Montgomery, 1829. Died. Guthrie and Broca.
2. Colson (de Noyon), 1840. Recovered. *Bull. de l'Acad. de Méd.* September 1841. Robert, *Sur les Anév. sus-claviculaires*.

b. For aneurism of the aorta.

1. Tillanus. Lived five months. Velpeau, *Méd. opér.*
2. Rigen, 1829. Lived three months. Died of hernia. Velpeau, *ibid.*
3. O'Shaughnessy. Died seven days afterwards. Galvano-puncture also. *Dub. Med. Press*, October 5, 1842.
4. Knowles, 1867. Died of apoplexy. *Lancet*, June 13, 1868.
5. Heath, 1872. Great improvement. Survived four and a half years. *Clin. Soc. Trans.* vols. v. p. 113; x. p. 96.
6. Pirogoff, date uncertain. Improved. *Kriegschirurgie*, 1864, p. 458.
7. Do. do. Fatal third week. *Ibid.*
8. Holmes, 1875. Great improvement. Alive and tolerably well when last seen in 1880, though the aneurism was not cured. *Clin. Soc. Trans.* vol. ix. p. 114.
9. Barwell, 1877. Much improvement. Death four months afterwards from disease of liver and kidneys. Barwell, *On Aneurism*, p. 104.
10. Pick, 1878. No improvement. Alive when last heard of. *St. George's Hospital Reports*, vol. ix. p. 334.

¹ This operation was performed about the year 1859, and was communicated verbally to me by the operator.

III. SIMULTANEOUS DOUBLE DISTAL LIGATURE OF CAROTID AND THIRD PART OF SUBCLAVIAN.

a. For aneurism of the innominate—as diagnosed.¹

1. Rossi, 1843. Carotid and first (?) part of subclavian. *Dub. Gaz. Med.* 1844, p. 58. Broca, *On Aneurism*. There is some doubt as to the portion of the artery tied. In the *Gaz. Méd.* the words used are 'en dehors du muscle scalène,' but this is I think a clerical error.
2. Cuvellier, 1859. Died. Demme, *Spec. Chir. d. Schusswunden*, p. 210. The aneurism was rather subclavian than innominate.
3. Durham, 1871. Died six days, from shock of operation. *Lancet*, July 20, 1872, p. 67.
4. MacCarthy, 1872. Died fifteen days, from hæmorrhage. Maunder, *Surgery of the Arteries*, p. 22.
5. Eliot, 1876. Died twenty-six days. Hæmorrhage from the sac. *Am. Journ. Med. Sci.* 1877, p. 374.
6. Weir, 1876. Died fifteen days. Rupture of sac. Wyeth, *loc. cit.* case xiii.
7. Eusor, 1874. Died sixty-five days. Rupture of sac. *Lancet*, Feb. 6, July 31, 1875.
8. K. King, 1876. Died one hundred and eleven days. Rupture of sac. *Lancet*, vol. i. 1878, p. 823.
9. Holmes, 1871. Died two months. No improvement from operation. Galvano puncture, followed by diffuse inflammation of sac and parts around. *St. George's Hospital Reports*, vol. vi. p. 233.
10. Lane, 1871. Died seven weeks. Rupture of sac. *Lancet*, vol. 1872, p. 45.
11. Hodges, 1868. Died twelve days. Exhaustion. *Boston Med. and Surg. Journ.* Aug. 6, 1868.
12. Ransohoff, 1879. Died seven days. Asphyxia. *Am. Journ. Med. Sci.* Oct. 1880.
13. Pollock, 1880. Died ten days. Growth of aneurism. *Brit. Med. Journ.* March 26, 1881.
14. Barwell, 1877. Died from anæsthetic. *Med.-Chir. Trans.* vol. lxii. p. 218.
15. Little, of New York, 1877. Practical cure, *i.e.* the aneurism was consolidated, all but the channel for the subclavian, and the symptoms were relieved. Died three and a half years afterwards of pleurisy. Wyeth, *loc. cit.* case viii.
16. Stimson, 1880. Recovery with marked improvement. Remained well more than a year after operation. *Am. Journ. Med. Sci.* July 1880. Stimson, Holmes's *Syst. of Surgery*, American edition, by Packard, vol. ii. p. 421.
17. Barwell, 1877. Cure claimed. Died of bronchitis three months afterwards. *Med.-Chir. Trans.* vol. lxi. p. 13. Barwell, *On Aneurism*.
18. Barwell, 1877. Cure claimed. Died of bronchitis two years afterwards. *Med.-Chir. Trans.* vol. lxii. p. 218. Barwell, *On Aneurism*, p. 111.
19. Barwell, 1878. Cure claimed. *Ibid.* p. 224.
20. H. W. Langley Browne, 1881. Improvement when reported. *Brit. Med. Journ.* 1881, vol. ii. p. 780.

b. Double distal ligature, &c. for pure aortic aneurism.

1. Hobart, 1839. Carotid and first (?) part of subclavian. Died sixteenth day from hæmorrhage from the carotid wound, the subclavian ligature having come away. The preparation does not show anatomically the part of the subclavian artery which was tied. *Lancet*, July 13, 1872, p. 38.
2. Heath, 1865. Survived four and a half years. *Lancet*, Jan. 5, 1867. Referred to in the text.
3. Maunder, 1867. Died. *Path. Soc. Trans.* vol. xix. p. 93.
4. Sands, 1868. Died thirteen months, from growth of tumour, *Am. Journ. Med. Sci.* April 1869, p. 568. Wyeth, *ibid.* Jan. 1881, case ii.
5. Fleet Spier, 1874. Died thirty-four days, from rupture of sac. Wyeth, *loc. cit.* case vi.
6. Barwell, 1879. Temporary recovery with improvement. *Med.-Chir. Trans.* vol. lxii. p. 393. Died fifteen months. Barwell, *On Aneurism*.
7. Wyeth, 1880. Recovery with improvement. Wyeth, *loc. cit.* case i.

IV. CONSECUTIVE DOUBLE DISTAL LIGATURE.

1. Fearn. Carotid, August 30, 1836; subclavian, third part, August 2, 1838. Died four months after the last operation. *Lancet*, 1837, 8, 9.
2. Wickham. Carotid, September 25, 1859; subclavian, third part, December 3, 1839. Died. *Lancet*, 1839; *Med.-Chir. Trans.* 1840.
3. Malgaigne. Carotid, March, 1845; axillary, first part, October 17, 1845. Died. *Bull. de la Soc. Anat.* 1848, vol. xxiii. p. 291.

¹ In many of these cases, it must be recollected, the aorta was involved.

4. A. B. Mott. Carotid tied in 1875; subclavian in 1876. Practical cure. Death from phthisis in 1879. Wyeth, *loc. cit.* case xxv. (*Mem.*—The reality of the existence of any aneurism at all in this case is uncertain, as shown by the report of the dissection by Dr. Stimson in *Am. Journ. Med. Sci.* April 1881.)
5. Bickersteth. Carotid tied May 1864; subclavian, June 1864. Forty-nine days later temporary improvement. Death in three months from progress of disease.
6. Adams and Treves, 1880. Carotid tied June 30; subclavian July 21. Innominate aneurism practically cured. Death from rupture of an aneurism of the aorta 108 days afterwards. *Med.-Chir. Proc.* vol. ix. p. 25.

The above tables will show how actively the process of testing the distal ligature in aneurism at the root of the neck and in the thorax has gone on of late years, and I think that the success obtained has been such as at any rate to justify the proceeding. But we must allow that as yet it is very difficult indeed to specify the precise cases in which the operation should be recommended, the precise artery or arteries which should be tied or the *rationale* of the process by which the cure or improvement is to be brought about. This however is perhaps no more than might be expected in a method still comparatively novel, and which is undertaken for the treatment of a disease so exceedingly formidable, and so difficult of precise diagnosis.

One thing I think has been fully proved, viz., that the distinction which was so much insisted on, between aortic and innominate aneurism, is of less importance in regard to the distal operation than used to be taught, and that a case of innominate aneurism which otherwise seems appropriate for operation need not be rejected because it is suspected or known that the aorta is also involved. It has also been satisfactorily proved that aneurisms purely aortic have been much benefited by distal operations. It remains to inquire what cases should be selected, and what arteries should be tied in each case.

To my mind the clearest evidence of benefit has been in the case of ligature of the left carotid in the treatment of aneurism affecting the transverse portion of the arch. This operation, originally suggested by Dr. Cockle¹ as a deliberate surgical proceeding, was performed by Tillanus and Rigen on mistaken principles, but with considerable benefit—as will be seen by the histories of Cases II. *b.* 1, 2, in the table. Since the appearance of Dr. Cockle's pamphlet the operation has been practised by Mr. Heath, Mr. Barwell, and myself with great benefit; particularly in my patient, who is, I believe, now alive and enjoying moderate health, seven years after the operation. In other cases, as in Cases II. *b.* 3, 4, 10, the operation has failed to produce any improvement, but the above measure of success is amply sufficient to induce surgeons to repeat the proceeding in appropriate cases.

The ligature of the right carotid alone in innominate or mixed innominate and aortic aneurism is certainly not regarded with so much favour by most surgeons. Yet I venture to think that the evidence in favour of the success of the consecutive ligature in innominate and mixed aneurism is even stronger than that of the simultaneous ligature, and in all these cases the treatment has commenced with the ligature of the carotid. Now the ligature of the right carotid alone counts at any rate one complete success, viz. Evans's case (Table I. *b.* 1) in which the man was restored to complete health, and lived to an age beyond the ordinary term of existence, an active and indeed an imprudent life. In Morrison's case also (*ibid.* No. 5) the disease was cured; while in Wright's (No. 13) the aneurism seems to have been practically cured, though the patient died twelve weeks after the operation from abscesses in the brain.²

I am therefore, as far as present evidence goes, in favour of commencing the treatment of a case of presumed innominate aneurism, selected as one appropriate for distal ligature, by the operation on the right carotid, to be followed if necessary by that on the subclavian.

As to the results of the double distal ligature the tables speak for themselves. I cannot say that they comprise all the cases which have occurred up to the present

¹ Dr. Cockle's original paper is in the *Lancet*, March 27, 1869.

² See these cases more fully discussed in my lectures at the College of Surgeons (*Lancet*, July 20 and 27, 1872).

time, but they include all that Dr. Wyeth tabulated in his article in the 'Am. Journ. Med. Sci.,' Jan. 1881, with a few added, which have fallen under my own notice since that publication. It will be noticed that while the number of cases of consecutive is much less than that of the simultaneous double ligature, the proportion of success is much greater. I would not urge this as in any way conclusive, since the amount of our experience is as yet insufficient for any confident conclusion; but it is I think a strong argument for following a course which has already produced such good results, at least in cases of innominate aneurism. Nor do I see why an experimental trial of the ligature of the right carotid by itself should not be made in cases of aortic aneurism. If ligature of the left-carotid has been beneficial (as undoubtedly it has) in some cases of aortic aneurism, why should there not also be cases in which ligature of the right carotid would be of service, and why should it be necessary to tie the subclavian also?

This question leads up to the great difficulty in this discussion, viz. How does the distal operation produce the consolidation of an aneurism; and what are the cases of innominate and of aortic aneurism which are likely to be benefited by it? I do not find much of definite theory on the former point in the writings of those who have most occupied themselves with this operation, viz. Dr. Cockle, Mr. Barwell and Mr. Heath. Speaking generally, I think I may say that they adopt the teaching of Wardrop, viz. that the distal ligature reduces the circulation through the aneurism, and thus produces consolidation. I have elsewhere, however, tried to support the other view, viz. that it acts by producing coagulation of blood in the tied artery, and that such coagulation extends gradually into the portion of the sac from which the tied artery originates, just as the impaction of clot in the carotid artery sometimes leads to the practical cure of an innominate aneurism. This explanation, however (though I have no doubt of its occasional truth — *i.e.* I have no doubt that in some cases cure is thus produced) only applies to the ligature of the carotid artery, since the ligature of the third part of the subclavian still leaves the first part open as it quits the sac.¹ And I cannot deny that in some cases there is distinct evidence of benefit from the subclavian ligature. Probably both explanations are true to a certain extent. The ligature of the carotid has the most direct effect on the tumour, for if the whole artery gets blocked up with clot (as it often does), that clot will spread down into the tumour; and if the whole artery is not blocked up, yet no further circulation will go on through it, between the ligature and the aneurism; so that the part of the sac through which the blood passed into the carotid will probably become obliterated. The action of the subclavian ligature is not so easy to explain. Mr. Barwell's case might be used to show that the same thing is possible here also; but in ordinary cases, where the first part of the subclavian remains open, it may still be true that during the period of enlargement of the collateral vessels, the circulation is much diminished, and that the blood has time to coagulate during this interval; and this coincides with the fact that sometimes after distal ligature the tumour is observed at once to collapse to some extent and to lose some of its pulsation.

The applicability of the distal operation seems to me to depend on the observed growth of the tumour in such a direction as may appear to correspond with the circulation in the arteries which it is proposed to tie. Thus, in the case of aneurism of the arch of the aorta in which I tied the left carotid artery (II. b. 8) it was the evident extension of the tumour up the neck and towards the trachea which made me think that the ligature would prove beneficial, and the result even surpassed my expectations. So if, in an innominate or mixed aneurism, the tumour

¹ It is true that in one of Mr. Barwell's cases he affirms that on post-mortem examination the whole subclavian artery was found obliterated. But this must either have been an error (the examination being hastily conducted, and the subclavian artery accidentally cut across), or an exceptional circumstance due to some accidental disturbance of the clot in the aneurism. Few surgeons would doubt that under ordinary circumstances the collateral circulation after ligature of the third part of the subclavian is carried on through the branches of the first part, and that this part of the artery therefore remains patent.

were making rapid advances under the sterno-mastoid muscle, I should think the ligature of the subclavian artery justifiable, though, as I have said above, I do not regard this operation with as much confidence as the ligature of the carotid. The presence and localisation of venous obstruction is also an important sign, though not a very easy one to estimate, for the relations of the left innominate vein to the aorta and its great branches are so extended that a tumour which may lie chiefly on the right side of the middle line may easily produce congestion of the left side. The symptoms of pressure on the nerves of either side, as shown by irregularity of the pupil, or by paralysis of the vocal cord, are of great importance, and so are the symptoms showing pressure on one or other bronchus.

I fear we cannot at present be more definite than this; but I would direct the reader's attention to Mr. Barwell's treatise on 'Aneurism,' in which he attempts to render the diagnostic indications more precise.

Old operation for carotid aneurism.—The treatment of aneurism at the root of the neck, at least when it follows a wound, was successfully carried out by Mr. Syme on the old method, by laying open the tumour and searching for both ends of the vessel. An abridged account of this daring operation is appended; the reader, however, can have no idea of the risks and difficulties of such a proceeding without perusing the fuller account in the original, and even then his idea will be but a faint and imperfect one.

The operation performed by Mr. Syme may be thus summarily described.¹ The patient had been stabbed in the root of the neck about two months before, and an aneurism had formed, connected with the lower part of the left common carotid. This had been advancing rapidly, under compression applied to the tumour, so that it was necessary to do something. Mr. Syme made a small opening into the pulsating tumour with a bistoury, and then passed in his finger so as to plug the puncture, and felt about till he got upon the spot where pressure controlled the pulsation, and where, therefore, the opening lay. Keeping this point firmly compressed, he laid the sac freely open, and sponged out the clots. A smooth serous surface was exposed, with no trace of artery or vein. The skin and sternal portion of the sterno-mastoid having now been divided by a transverse incision (pressure being still kept upon the opening with the finger), the edge of the slit in the artery which lay under the finger was caught with catch-forceps and the vessel drawn towards the trachea; it was then carefully scratched with a knife, till the arterial coat was brought into view on the external edge, and a ligature passed round it above the aperture. The same proceeding was repeated below the opening; and now the finger could be withdrawn without the tremendous gush of blood which had before followed its displacement.

It is clear that such an operation as this can be successfully performed (that is to say, performed without instant death resulting) only by a surgeon who possesses a large share of that fertility of resource and dexterity in operating which Mr. Syme showed in so great a degree in this case. On the general question, as to whether a case like the above ought to be treated on Brasdor's plan, or as Mr. Syme treated it, it would be rash to affect to give a positive opinion; much would depend upon the confidence of the surgeon in himself. If he felt able to carry out to a successful conclusion so difficult an operation, he would probable imitate Mr. Syme's practice; if not, he might try the distal ligature of the carotid. Should Brasdor's operation fail to check the progress of the tumour, the old operation might be tried, and even a faint prospect of life might remain to the patient from an attempt made to secure the artery after the aneurism had burst.

The above operation indicates so clearly the steps that should be taken in securing the carotid on account of a wound, that no further description of that proceeding is necessary.

ANEURISMS IN THE UPPER PART OF THE NECK, THE ORBIT, AND THE CRANIUM.

Aneurisms above the root of the neck will generally be found to affect either the common carotid just at its bifurcation, or the arteries of the orbit or cranium. Some cases of aneurism of the secondary carotids are also on record. The diagnosis

¹ *Observations in Clinical Surgery*, p. 154.

in either of the two former situations can generally be established satisfactorily ; but few things are so difficult as to distinguish from each other the various diseases which may cause pressure on parts of the brain, or disturbance of the cerebral functions.

The occurrence of dilatation at the upper end of the common carotid artery in a slight degree is natural ; and this natural dilatation is comparatively often so far increased that an aneurism results. It is an old observation, that the carotid is the only form of surgical aneurism which is equally frequent in both sexes, if it be not even more common in women. The diagnosis of aneurism situated in any part of the neck, above that portion of the carotid which lies in the immediate vicinity of the subclavian, cannot present any especial difficulty if the sac is formed and the pulsation distinct.¹ The proximity of the tumour to the air-passages and to the nerves which supply the larynx may cause dyspnœa, hoarseness, or even loss of speech, nausea, and perhaps impairment of appetite. There will also be giddiness, and trouble in the head ; and perhaps pain, numbness, or other nervous phenomena over the head and face.² These symptoms call for decisive and efficient surgical treatment.

Intra-orbital aneurism is very difficult to diagnose, in consequence of the fact that its main symptoms, exophthalmos, bruit and pulsation may be simulated by obstruction to the venous circulation in the cavernous sinus, and also to some extent by traumatic rupture of the carotid artery in the sinus. The first cases of pulsating tumour in the orbit were described on the authority of Travers³ as aneurisms by anastomosis ; but Mr. Busk⁴ and Mr. Nunneley,⁵ I think, conclusively refuted this view, and proved that the history, symptoms, and results of treatment of many of the recorded cases agreed more nearly with those of common aneurism than with either aneurism by anastomosis, or congenital arterial nœvus ;⁶ nor has any case been dissected up to the present time in which the symptoms have been proved to depend on aneurism by anastomosis.

Twelve cases have been examined post mortem.⁷ The affections on which the symptoms have been proved, by dissection, to depend are : 1. Ordinary circumscribed aneurism in one case—that of Guthrie—very imperfectly described. In one (Oettingen's case), death occurring two years afterwards, there was evidence of old inflammation of the orbital veins, but the condition of the intra-cranial vessels is not described. In all the other ten cases the disease was situated behind the orbit ; in one of these (Nunneley's) there was aneurism of the ophthalmic artery in the cranium. In three others (Baron's, Gendrin's, and Nunneley's) there was aneurism of the internal carotid which had burst into the cavernous sinus. In one (Wecker's and Richet's case) the internal carotid seems to have been dilated and atheromatous, though not aneurismal ; but the case is badly described : in three cases, two under the care of Nélaton, and the other of Hirschfeld, there was traumatic lesion of the carotid artery in the sinus and a communication was thus established between the artery and the venous channel. In the other two cases (Bowman's traumatic, and Aubry's idiopathic) there was no arterial lesion whatever, but the sinuses were obstructed.⁸

¹ In a case where the carotid artery gave way through a small atheromatous ulcer, and the blood was not at first confined in any sac, there was for some time much difficulty in establishing the diagnosis. The preparation and history are in St. George's Hosp. Museum, Ser. vi. No. 112.

² See the account of Sir A. Cooper's case, *Guy's Hospital Reports*, vol. i. p. 53.

³ *Med.-Chir. Trans.* vol. ii. p. 1.

⁴ *Ibid.* vol. xxii. p. 123.

⁵ *Ibid.* vols. xlii. xlviii.

⁶ I followed Mr. Rivington in making a distinction between these two affections in their origin, though in their anatomy they are identical. Mr. Haynes Walton's case (*Surg. Dis. of Eye*, 2nd. ed. 1861, p. 230) appears to have been one of congenital arterial nœvus, but this could not be proved anatomically, as ligature of the carotid was perfectly successful.

⁷ The cases will be founded abstracted and referred to in the Appendix to Mr. Rivington's paper, *Med.-Chir. Trans.* vol. lviii. pp. 256 *et seq.*

⁸ It seems strange that an affection characterised by so many of the symptoms of aneurism—viz. loud bruit, vascular tumour, and arterial pulsation—should yet in some cases be perfectly independent of any arterial disease whatever. Yet the dissections of Mr. Bowman's and

The above short reference to the results of all the post-mortem examinations which have been made in cases of so-called 'orbital aneurism,' form, I think, a useful introduction to the study of this difficult subject, for they show plainly enough that somewhat similar symptoms are produced by affections which are very different indeed in their pathological nature; and that of those which are aneurismal, only a few deserve the name of orbital or intra-orbital, the majority of the aneurisms being in the sinus. Besides which, it has been proved that aneurism may exist in the sinus without any pulsating tumour in the orbit.¹ The subject, therefore, is one of great complexity, and neither its diagnosis nor treatment can yet be said to be settled. I can only here attempt a brief sketch of what is known to surgeons on the subject at present.

Pulsating exophthalmos, or vascular protrusion of the eyeball, is accompanied by the sensation of a soft pulsating and usually easily reducible tumour generally lying above the globe of the eye at the inner angle of the orbit, considerable congestion of the conjunctiva, forming what is called by Mr. Rivington 'a chemosed pad,' concealing the lower lid, the pulsation communicated to the protruding eyeball, more or less loss of vision and paralysis of ocular muscles in different cases, and bruit audible on auscultation and to the patient himself.

In estimating the probable cause of these symptoms, it is important in the first place to separate traumatic from idiopathic cases. Mr. Rivington has shown that in traumatic cases the symptoms probably always depend on fracture of the base of the skull, producing laceration either of the venous sinus, with subsequent obstruction, or of the internal carotid artery in the sinus with subsequent arterio-venous communication (aneurismal varix) between the artery and the venous channel with its radicles in the orbit. Such were Nélaton's and Hirschfeld's cases, and they appear to be marked by the peculiar bruit, which is described as 'a piping whining sound, *bruit de piaulement*, heard at intervals, in addition to a continuous murmur and intermittent whiz' (Rivington). In such cases the diagnosis of arterio-venous communication in the cavernous sinus may very reasonably be made. The symptoms do not always come on at once after the injury, some accidental circumstance having probably at first obstructed the opening. In traumatic cases, where this peculiar bruit is not heard, but only the ordinary continuous rushing sound with intermittent bruit (likened by Mr. Hulke in his account of Bowman's case to the noise of a steam-engine), it must remain doubtful whether the symptoms do not depend entirely on obstruction to the venous channel, as in that case they were proved by post-mortem examination to have done.

In idiopathic cases the diagnosis is much more difficult. A careful examination of the pulsating swelling is necessary, but it does not commonly lead to any distinct conclusion, as the tumour usually consists obviously of dilated veins, and it is hardly possible to form an opinion whether they themselves pulsate or derive pulsation from an aneurism lying against them and obstructing their circulation. In some cases, however, it may be possible to feel a hard defined pulsating sac, and then if the character of the bruit is clearly that of arterial aneurism, the diagnosis will be clear. If, on the other hand, the tumour is only venous and the bruit is clearly arterio-venous (and especially of the peculiar nature above described), the probability is that

other cases have put the matter beyond all doubt. The peculiar relations of the internal carotid artery to the great venous channel into which most of the orbital veins run is no doubt the cause of this strange peculiarity, though surgeons are not quite agreed on the exact mechanism of the symptoms. It seems to me that when the cavernous sinus is obstructed, the veins behind it become dilated into large varices, and these receive pulsation from the artery, or it may be the aneurism, in the sinus. The pulsation is more powerful when an opening has formed between the artery or aneurism and the venous channel. When there is no arterial disease, the bruit must be attributed to the narrowing of the channel of the artery, produced by the pressure of the coagula in the sinus. Mr. Hulke, in relating Bowman's case, gives a somewhat similar explanation. 'Each diastole of the ophthalmic artery must have been attended by a general momentary increase of the whole quantity of blood in the orbit, because its exit through the ophthalmic vein was cut off, and the resisting bony walls of the orbit could permit a distension in front only.'

¹ See cases by Giraudet, Hutchinson, myself and others, quoted by Rivington, *op. cit.* p. 218.

a small aneurism of the internal carotid artery has given way into the venous channel of the cavernous sinus and has produced varicose enlargement of its branches in the orbit. Besides these cases there will be many in which the surgeon will remain in doubt whether there is anything more than thrombosis of the sinus and its branches. True arterio-venous aneurism has never been found in idiopathic cases; but Mr. Lansdown, of Bath, successfully operated on a small pulsating tumour forming in the cicatrix of a wound in the orbit, which he judged to be of this nature.¹ The occurrence of cirroid aneurism is unproved. Mr. Haynes Walton has recorded a case² which he regards (and with great probability) as one of aneurism by anastomosis or congenital arterial nœvus. Cases believed to be of this nature require to be carefully diagnosed from pulsating cancerous tumours, as to which, however, the diagnosis is the same as in other regions of the body.

So much having been said as to the pathology and diagnosis of these obscure cases, it remains to speak of their treatment. Now in the first place several cases both traumatic and spontaneous seem to have done very well without any treatment at all,³ or with medical treatment which we can hardly look upon with much confidence, as it has not proved efficacious in aneurisms of other kinds. Nor is this very surprising if we regard them as cases of mere thrombosis, whether from injury or from some diseased condition of the blood, or of the walls of the sinus. Such thrombosis we know is not always permanent, and, if it be, the gradual enlargement of anastomosing venous channels may remove its effects, or so much diminish them as to leave the patient in a tolerable condition. The first consideration then ought to be, in any case not plainly aneurismal or not visibly advancing, whether the patient would not do best to follow the expectant plan.

But if, from the symptoms above detailed, the surgeon has no doubt of the aneurismal nature of the tumour, the best course seems to be to test the effect of digital pressure on the carotid artery, and if this is not well borne, or is ineffectual, to tie the artery, a measure which has been on the whole very efficacious.⁴

In cases of doubtful nature, and where the symptoms are advancing so that expectancy seems unjustifiable, I should try the effect of the injection of the soft pulsating venous tumour with some salt of iron, the perchloride, I think, being the best, though the lactate has been successfully used. But on the failure of this, the carotid should be tied, as was done in Mr. Rivington's case.

Those cases which are certainly or probably arterio-venous communications in the cavernous sinus will in all probability not yield to any measure short of the ligature; and the success even of this is not very certain.

In a few cases the symptoms have persisted, or possibly recurred, after ligature of the carotid.

Aneurism may also affect either the internal carotid artery, in its bony canal or in the cavernous sinus, or one of the arteries of the brain. The symptoms of aneurism affecting the internal carotid in the sinus are mainly of three kinds: (1) the symptoms of aneurism; (2) the symptoms of pressure on the orbital nerves; (3) those of disturbance of the cerebral circulation.

(1) In a well-marked case the symptoms of aneurism will come on rapidly, very likely after a blow or other injury; there will be, perhaps, a sharp crack heard,

¹ *Brit. Med. Journ.* June, 5, 12, 28, 1875. Rivington, *op. cit.* p. 297.

² Rivington, *op. cit.* p. 261.

³ These are collected by Rivington, p. 243.

⁴ Forty-six cases of ligature of the common carotid on 44 patients are given by Mr. Rivington (p. 248), 18 of which were idiopathic cases, 15 recovered, and 3 died. The other 26 were traumatic cases, 23 recovered, and 3 died, in one case after galvano-puncture. In two of the successful cases both carotids were tied. Of the 15 idiopathic cases which recovered from the ligature, 12 were cured of the aneurismal (?) affection, and in 8 cases at least vision was restored. In 3 it was known to have been lost. Of the 23 traumatic cases, 14 were completely cured at once, and two others after ligature of the other carotid, and in 10 of these 16 the cure was complete; 4 of them however, at least, lost vision. One other was subsequently cured by injection of lactate of iron.

followed by a sawing or rasping noise. This sound will be perceived by the stethoscope, applied to the head or neck, more plainly on the affected than the sound side, and will cease at once on making pressure upon the common carotid on the side of the disease. If the disease is limited to the part of the artery contained in the sinus, no tumour will be perceptible externally.¹ (2) The first symptom of pressure upon the orbital nerves is either internal strabismus, from paralysis of the sixth nerve;² or ptosis, with external squint and dilated pupil, from pressure on the third nerve;³ or loss of sensation in the parts supplied by the supra-orbital nerve.⁴ Sight on the side of the disease is usually not affected; sometimes, however, objects are seen double, or there is more or less indistinctness of vision, the consequence probably of the dilatation of the pupil. These symptoms of pressure on the orbital nerves may exist singly, or in various combinations. (3) The symptoms of cerebral disturbance do not seem greater in a moderately early case of this affection than in aneurism of the common carotid: headache, giddiness, inability to stoop, frightful dreams, &c. There is no pressure on the brain, since the growth of the tumour is opposed by the dura mater. It seems possible that the aneurism might grow through this membrane, and cause softening of the base of the brain; but I have not met with such a case.

With such a combination of symptoms, then, the diagnosis of aneurism may reasonably be made; and the case may justifiably, in the present state of our knowledge, be treated as such, as in a case under the care of Mr. Coe of Bristol and Dr. Swayne,⁵ where the artery was tied with complete success, in a case diagnosed with all appearance of truth as one of aneurism of the internal carotid. The symptoms were relieved, and the patient, as I was informed by Mr. Coe, was in perfect health ten years after the operation.

The symptoms of aneurism of one of the small arteries at the base or in the substance of the brain, are as yet quite obscure. Physicians and physiologists are busily endeavouring, by experiment and the study of cases, to decide how, from the symptoms of limited pressure or other limited lesion, to determine the precise part of the brain affected. Even if this great difficulty were got over, how are we to decide whether such limited injury depends on pressure by an aneurism, or by a tumour of a different kind, say a scrofulous tubercle?⁶ The rapidity of the onset of the symptoms, and the variation in their severity, occasioned by different states of the circulation, seem the only peculiarities which point to aneurism, and they are excessively doubtful and delusive. We have, indeed, no means at present of diagnosing cerebral aneurism, unless a bruit could be found; and in looking over a number of cases I do not find any mention of this symptom having been looked for. In Dr. Ogle's case, however, the patient was herself conscious of 'a sawing noise' in the head. It seems, therefore, that in similar cases the head should be carefully auscultated, though it is very likely that the small size of the aneurism and of the vessel on which it is seated, and the mass of soft, ill-conducting parts that lie over it, would prevent bruit from being heard.

Treatment of carotid aneurisms.—Aneurisms situated in the carotid triangle of the neck must be treated on ordinary principles, digital pressure on the trunk of the vessel being used in cases where the symptoms are not very urgent, combined, perhaps, with moderate pressure over the tumour (*vide* p. 67); in severer cases, or on the failure of these measures, the common carotid artery must be tied.

The ligature of the common carotid in an ordinary case of aneurism, where the

¹ It would seem from Mr. Nunneley's cases that in some of these aneurisms in the sinus, or even more internal, there may be pulsation and fulness in the orbit. I have seen such aneurisms, however, unaccompanied by any orbital symptoms.

² *Assoc. Journal*, 1855, p. 1067.

⁴ *Id. ibid.*

³ *Path. Soc. Trans.* vol. xii. p. 61.

⁵ *Assoc. Journal*, 1855, p. 1067.

⁶ See, in *Med.-Chir. Trans.* vol. xlii. p. 403, a paper by Dr. Ogle, in which he carefully endeavours to point out how, from the symptoms presented in the case there related, he might have diagnosed lesion limited to the pons Varolii. Even had he done so, however, he would have referred the lesion to pressure by a scrofulous tumour, while it was in reality an aneurism of the anterior cerebellar artery.

patient is not very stout, the aneurism not situated near the root of the neck, but towards the angle of the jaw,¹ and the parts healthy, is generally an easy operation. The artery can be felt, in any person not extremely stout, pulsating on the anterior edge of the sterno-mastoid muscle, at the level of the cricoid cartilage, where it first becomes superficial, after having been crossed by the omohyoid muscle—the apex of the carotid triangle. This is accordingly the place of selection for the ligature. The operation is thus performed: If the sterno-mastoid muscle is perceptible, an incision about two and a half inches in length (in a moderately stout adult) is to be made along its anterior edge, the centre corresponding to the level of the cricoid cartilage; and after the cervical fascia has been divided, which may be done freely, as no important parts are endangered, the edge of the sterno-mastoid ought to be exposed. This having been drawn a little outwards, the finger should be passed into the wound, to feel for the trachea, when the artery will be felt lying between the muscle and the air-tube. If the tendon of the omohyoid comes into view, it should be drawn upwards or downwards as seems most convenient. The latter would be the usual course. The operator must now carefully separate the cellular tissue from the sheath which covers the artery, and endeavour to raise the descending branch of the ninth nerve, which generally lies upon the sheath. This nerve, when exposed, is to be held aside with a blunt hook, while a small opening is made in the sheath of the artery; and the vessel having been cleaned by the usual manipulations, the ligature is to be passed around it from without inwards, great care being taken to keep the point of the aneurism-needle quite close to the artery, so as to avoid wounding or tying the pneumogastric nerve. The operator must remember that the descendens noni nerve sometimes lies within, instead of upon, the sheath of the vessels; so that, when it has not been met with after a sufficient search, the artery may be tied without seeing it; but in this case even more than common care should be bestowed in examining the vessel as it lies upon the aneurism-needle, in order to make sure that this nerve has not been included. In the course of the dissection some bleeding may occur from the sterno-mastoid artery, which is usually the descending branch of the superior thyroid, and may prove annoying to the operator unless the vessel be tied.

When the aneurism is situated lower in the neck, the operation becomes more difficult, since it is necessary to cut through a considerable mass of muscle. The artery is here situated under cover of the sterno-mastoid with the sterno-hyoid and sterno-thyroid muscles. An incision must be made along the course of the artery, viz. the line joining the sterno-clavicular articulation with the point midway between the angle of the jaw and the mastoid process, and this incision may be joined by another running outwards. The inner, or sternal, portion of the sterno-mastoid is to be cut across, and this being drawn outwards, with a broad retractor, it will be generally possible to draw the two other muscles inwards, otherwise they must be divided. The sheath of the vessels will now be exposed; but there will in all probability be several large veins lying over it, which descend from the thyroid body, and on the left side of the neck the internal jugular itself inclines considerably to the front of the artery towards the thorax. The wound is also very deep, and the vessel is probably rendered relatively deeper by the projection of the tumour. Still, by keeping the course of the vessel steadily in view, and by feeling for the trachea internally and the transverse processes of the vertebræ behind, the artery must be reached. Great care, however, is necessary in opening the sheath and cleaning the artery, since the vessel itself can hardly be brought fairly in view. The proximity of the stream of blood in the innominate artery on the right side is a great, but not a fatal, objection to this operation. Porter² tied the right carotid

¹ This observation of course applies still more forcibly to the cases in which the disease is situated in the orbit, and therefore quite away from the parts operated on; but in a case where Brasdor's method was applied for a tumour at the root of the neck, and in a case of Hunterian ligature, where the tumour was lower down than usual, I remember seeing considerable difficulty experienced by the operators from the circumstance that the artery had been displaced backwards by the pressure of the tumour.

² *Sup. cit.*

successfully within half an inch of the bifurcation of the innominate, and an American surgeon¹ has recently related a case in which he professes to have tied the left common carotid, within half an inch of its origin from the aorta. I must say, however, that the account, both of the operation and of the post-mortem examination which afterwards took place, are not very intelligible.

The mortality after ligature of the common carotid artery in former times, as calculated from the tables given by Norris,² Pilz,³ and Le Fort,⁴ would appear to have been about one-third, when the operation was undertaken for aneurism. But, as I have already said, the mortality after ligature of large arteries is so much diminished by the modern methods of treating wounds, that it would only serve to mislead the reader if I were to dwell on this fact. Nor do I know that we are yet in a position to estimate correctly the danger of the operation *per se*. I can only say that in the comparatively few cases in which I have myself tied this vessel, and seen it tied, I have never seen any bad symptoms,⁵ and that in almost all the cases in which it has of late years been tied on the distal side of a thoracic or cervical aneurism, the operation has appeared to be quite harmless. I would not, however, on that account represent the ligature of the carotid as being a trifling step in the treatment of any case, and more particularly when it is tied on the proximal side of an aneurismal tumour; for our experience hitherto is obviously too recent to enable us to dogmatise on the subject. All that I would say is that, with the modern method of treating wounds, and with the kinds of ligature which have been recently introduced, the surgeon need have no hesitation in undertaking the ligature of this artery in any case where he has reason to think that it is indicated.

The chief causes of death after ligature of any large artery, excluding those affections which depend on previous disease and the complications which follow on any grave surgical operation, are secondary hæmorrhage and gangrene. The former is comparatively rare after ligature of the carotid, in consequence of its long course without branches. Still in former times it was not perhaps so uncommon as is generally supposed, since among the fifty-four fatal cases in Dr. Norris's table, hæmorrhage is noted as the cause of death in fifteen of them, and it may have been present as a symptom in many of those which recovered.

Gangrene shows itself principally in the form of softening of the brain. The external parts of the head and neck are never, as it seems, affected with gangrene; a fact which is readily accounted for by the free anastomoses and liberal supply of the vessels of the face and neck. The anastomoses in the brain are indeed even more abundant; but then the brain appears to be more in want of a constant and equable supply, and to tolerate badly the withdrawal for even a short space of so large a quantity of blood as is brought to it by this great artery. Twelve of the fifty-four cases in Dr. Norris's table seem to have proved fatal from some symptoms referable to the brain, which, however, are very variously stated; 'convulsions,' 'apoplexy,' and 'inflammation' of the brain, being the more common headings. It may be allowed us to doubt, in the absence of more exact information, whether this 'inflammation' was not, in most cases at any rate, atrophic softening.⁶

Either the external or internal carotid may be tied for a wound of the vessel itself in the carotid triangle. The operation does not essentially differ from that on the common carotid. An incision made in the same line, but higher up, will lead down directly upon the internal carotid. But the circumstances which would justify ligature of either of the secondary carotid arteries, except for wound, must be very rare. In aneurism affecting the internal carotid in the cranium, I have already stated the reasons which would lead me to prefer the ligature of the common carotid. I have not met with any account of cases of true aneurism of the branches of

¹ Porcher, *Am. Journ. Med. Sc.* Oct. 1878. ² *Contributions to Practical Surgery*, p. 251.

³ Laugenbeck, *Arch.* ix. 1868, p. 394.

⁴ *Gaz. Hebdom.* 1863, Nos. 28, 30, 35.

⁵ Except in one where by mistake a large vein was tied as well as the internal carotid artery. See the Table on p. 120, I. c. 3.

⁶ See the observations on this head in Dr. Pilz's paper, above referred to.

the external carotid, except traumatic aneurisms of the temporal artery, which are usually under the control of direct and indirect pressure, otherwise the temporal artery itself may be easily tied either by the Hunterian or the old method. But cirroid or anastomotic aneurisms of the branches of the external carotid are not so uncommon, and, upon the failure of other methods, it might be thought advisable to tie the external carotid artery. If so, it would be perhaps better to secure the arteries on both sides at the same operation, as was done successfully by M. Maisonneuve in four cases. In wounds of arteries derived from the common carotid, occurring in inaccessible situations, the common carotid artery itself has usually been tied, and with a certain measure of success.

Mr. Cripps, however, in a very interesting paper in the 61st vol. of the '*Med.-Chir. Trans.*,' argues very powerfully in favour of the ligature of the external, instead of the common, carotid artery in such cases as these.

We may, however, allow that every exertion should be made to secure the bleeding artery itself in any case, and that it is only where that operation is plainly impossible that it is justifiable to resort to so uncertain a measure as tying the trunk-vessel.

In order to find the external carotid, M. Guyon, who has written a special memoir on the subject,¹ gives the following directions. Make an incision downwards from a little external to the angle of the jaw to near the anterior edge of the sternomastoid, from one-third to half-an-inch below the upper border of the thyroid cartilage; dissect away some cervical glands and the venous branches, connected chiefly with the facial and lingual veins, which lie over the artery. The glands should not be torn away or lifted, for fear of tearing the veins, to which they adhere closely, but freely incised, and the veins tied and divided if necessary. Then look for the hypoglossal nerve, which crosses the artery perpendicularly, and will serve as a guide to the vessel lying immediately beneath. There is usually about half-an-inch of the trunk available for the purpose of placing the ligature, between the origin of the superior thyroid, which is generally close to the bifurcation, and that of the lingual, facial and occipital above. The identity of the vessel may be known by its relation to the hypoglossal nerve, the presence of a collateral (the superior thyroid) when it happens to come into view, and the fact that pressure on the exposed vessel commands the pulse in the temporal. In twenty-three of the cases mentioned in M. Guyon's paper, where this vessel was tied, none died from the operation, and none had secondary hæmorrhage. In four of these both external carotid arteries were tied, so that the number of patients was only nineteen. The twenty-fourth case quoted by M. Guyon was one in M. Maisonneuve's practice, where secondary hæmorrhage took place after the separation of the ligature: the common and internal carotid were tied, and the sympathetic nerve was injured. The patient died. Further particulars will be found in Mr. Cripps's paper.

Any of the branches of the external carotid which arise in the carotid triangle may require to be tied on account of a wound; but no special directions appear necessary. The diagnosis of the particular vessel injured would be impossible till the parts had been exposed, when the bleeding would be the only sure guide to the mouth of the artery. But the lingual artery may require ligature on account of disease or injury. The operation has now been frequently performed, either to check the growth of cancerous tumours or to arrest hæmorrhage from such tumours, or even from a wound. In either case it might be necessary to secure the artery on both sides.²

The operation is thus performed: the patient being in the recumbent position, with the head drawn over to the sound side, and a small pillow under the neck, an incision is made obliquely downwards and backwards, about two and a half inches in length, its centre being opposite the end of the great cornu of the hyoid bone. The

¹ *Mém. de la Soc. de Chir. de Paris*, tome vi. 1863.

² See Moore, *Med.-Chir. Trans.* vol. xlv. p. 56. The most complete memoir on the subject of ligature of the arteries of the tongue with which I am acquainted is by M. Demarquay, *Gaz. méd. de Paris*, 1867, p. 634.

superficial parts being divided, the point above mentioned should be kept in view, and the lingual nerve exposed. The artery runs deeper than the nerve to gain the deep surface of the hyoglossus muscle, and must be carefully searched for in the cellular tissue. This operation is more difficult than the description would seem to imply. The reason is, that as the parts are unsupported except by the loose and soft wall of the pharynx, the vessel is constantly retreating from the operator, who must be careful in conducting his dissection, for fear of wounding the pharynx. As the vessel is tortuous, it is necessary to keep close upon the end of the great cornu of the hyoid bone—the only sure guide to it. In the dissection, a large vein, the internal jugular or one of its branches, may be exposed.

The French method, which M. Demarquay seems to have adopted, is to make an incision more or less horizontal through the fibres of the hyoglossus muscle at the apex of the digastric triangle, below the level of the ninth nerve, and parallel to the hyoid bone. This is believed to be more certain than the other method, since the artery sometimes comes off from the carotid along with the facial, and in such cases passes downwards to gain the cover of the hyoglossus. Mr. Heath informs me that he tied the lingual artery in this manner for hæmorrhage in cancer of the tongue on January 1, 1869, and found no difficulty, though the operation was performed at night. On the division of the muscle, the artery at once presented itself.

The ligature of the smaller arteries of the neck is not a subject of any practical importance; but as the superior and inferior thyroid arteries have been tied in bronchocele, though the operation is not one which can be recommended, it may be as well to describe the method by which they may be secured.¹ For the superior thyroid an incision is to be made, two inches long, parallel to the inner margin of the sterno-mastoid, its centre corresponding to the great cornu of the thyroid cartilage. This brings into view the omohyoid muscle and the sheath enclosing the jugular vein and common carotid; the fibrous lamellæ which cover the artery having been torn apart with a director, the superior thyroid may be found running downwards between the vessels and the thyroid gland; or if the facial is the artery sought for, it can be found by the same incision, the search being conducted upwards towards the jaw, where the artery is found between the great vessels and the submaxillary gland.

The inferior thyroid is to be sought by an incision similar to that for the carotid in the lower part of the neck. It is usually concealed by the upper part of the omohyoid muscle. This muscle must therefore be depressed or divided, and the artery sought for between the trachea or œsophagus and the trunk of the carotid. The recurrent nerve and the descendens noni will be endangered in this operation.

REGIONAL SURGERY OF ANEURISMS IN THE ABDOMEN AND LOWER EXTREMITY.

THE FOOT AND LEG.

As in the upper extremity, so still more in the lower, aneurism hardly ever affects the arteries below the great hinge-joint, except as the result of accident. Spontaneous aneurism, it is true, is not unknown in the leg; but it is extremely rare. Two cases of aneurism, apparently spontaneous, of the dorsalis pedis artery have lately been put on record under the care of Mr. Adams and Mr. Savory.² The Museum of St. George's Hospital contains a specimen of aneurism of the posterior tibial artery cured by ligature of the femoral; and other scattered examples of these aneurisms may be found in pathological collections. These aneurisms, like those in the forearm, will hardly ever be found originating spontaneously except in subjects affected with extensive disease of the heart and arteries; and appropriate position, bandaging, and digital pressure on the first accessible artery above the tumour, will be the

¹ See Mott's *Velpeau*, vol. ii. p. 227. ² *Brit. Med. Journ.* Dec. 8, 1877, and Jan. 19, 1878.

appropriate means of cure for these, as for those. The use of Esmarch's bandage in aid of these measures seems very desirable in appropriate cases (see p. 74). If this treatment should fail, it will be for the surgeon to consider whether his patient has sufficient vital power to survive the ligature of the femoral artery, and whether the disease is grave enough to justify the risks by which that operation must be attended.

Pressure and proper position will, in all probability, stop bleeding from any vessel in the foot; but it is possible that a traumatic aneurism in the foot or near the ankle may necessitate the ligature of one or other of the tibial arteries; these vessels, however, are much more often tied on account of wound.

The *ligature of the anterior tibial* may be thus performed. If the vessel requires to be tied above the middle of the leg, it will be found very deeply placed on the interosseous membrane, between the thick muscular bellies of the *tibialis anticus* on the one side, and on the other of the *external longus digitorum* above, and *extensor proprius pollicis* below, tightly bound down by the fascia of the leg. In order to reach it on the living subject with any tolerable facility and in any tolerable time, the intermuscular space must be hit, and the vessels exposed without any groping about among the muscles. This can be easily done on the dead subject, but on the living the operation must be one of considerable difficulty. An incision, proportioned to the fatness of the leg (about four inches might be taken as a moderate length), is to be made in the line joining the head of the fibula with the middle point between the two malleoli. The skin and superficial fascia being separated from the deep fascia, a whiter line running down the latter will be seen marking the intermuscular space.¹ This is to be slit up to the same extent as the original wound, and the muscles drawn forcibly apart with broad retractors, the ankle being flexed in order to relax them. Then, at the bottom of the deep interval, the nerve will come into view, and below it the vessels will be found inclining to its inner side. Even in the dead subject there is often considerable difficulty in getting a ligature round the anterior tibial (especially if the operator wishes not to include the veins, which, however, in the living body would be almost a matter of indifference); and this difficulty would be much increased in practice by the fact that the operation would probably be undertaken on account of a wound, and that the neighbouring parts would be obscured by the extravasated blood, the muscles perhaps lacerated, and the cavity in which the vessel lies so deep that the bleeding, by which alone the artery could be recognised, would also constantly obscure and hide the bleeding orifice. In such an operation Esmarch's bandage would much facilitate the search for the wounded vessel. Great pains, however, should be taken to endeavour to restrain the bleeding by graduated compresses, or by digital pressure in the wound, before resorting to an operation which may fail, and, if it does so, may cost the patient his limb.²

In the lower part of the leg, where the muscles have ended in their tendons, and where the vessels are supported on the tibia, there will be much less difficulty in finding the artery; but the line of incision is the same, and the same muscle (*tibialis anticus*) serves as a guide, the artery lying on its outer side.

The remarks above made, as to the propriety of endeavouring, if possible, to avoid operating on small arteries so deeply seated as those of the upper part of the leg, apply to the posterior tibial, and still more forcibly to the peroneal, which, however, has been successfully tied on account of wound by Mr. Guthrie;³ but no special instructions are needed for this operation, which consisted merely of making a very long incision in the middle line of the calf (seven inches in length, with its centre at the wound), dissecting down towards the fibula, turning out the clots, and looking for the bleeding point; in doing which it was necessary to cross the incision by one running towards the fibula, so as to turn down two little flaps. The bleeding

¹ Guthrie recommends that the foot be alternately flexed and extended to bring these muscles into view more distinctly.

² I was told by Mr. Moore that in a case where he had occasion to tie the anterior tibial for a wound, he found much assistance to discovering the position of the vessel from tracing back its branches, which are given off in considerable numbers to the muscles around it.

³ *On Wounds and Injuries of Arteries*, p. 35. 1846.

point having been seen, a sharp hook was struck into the tissues below it, and the whole was tied up in two ligatures above and below the part whence the bleeding proceeded. As the patient recovered it was, of course, impossible to affirm that the peroneal was really the artery which had been tied.

Ligature of the posterior tibial in the upper part of its course, where it lies under the deep fascia which separates the mass of muscles forming the superficial layer of the calf from those which form the deeper layer, can be effected in one of two ways. The first of these consists in making an incision of suitable length (say six inches) along the posterior edge of the tibia, and, having divided the fascia, pulling the gastrocnemius away, cutting the soleus off the tibia to the extent to which it is exposed, and thus coming down upon the deep fascia, which covers the artery, and which is to be divided with the usual precautions, in order to search for the vessel lying below it. This way of making the incision, which is the old method of reaching the vessel, is condemned by Mr. Guthrie as 'difficult, tedious, bloody, and dangerous;' and he proposes to substitute for it a vertical incision along the middle line of the calf, over the position of the vessel, through the gastrocnemius and soleus muscles. Mr. Guthrie himself never had the opportunity of carrying out this suggestion; but it was put in practice by Mr. Arnott in a case where he tied the artery for a wound.¹

In that case, indeed, the position and direction of the external wound would have indicated some such course; but Mr. Arnott has put on record his preference for Mr. Guthrie's method, and advises that it should be followed if it should ever become necessary to tie the posterior tibial on account of aneurism situated low in the leg; a necessity which does not seem hitherto to have occurred.² Mr. Arnott, however, remarks about his operation what is probably even more applicable to the old procedure. 'It is not one which should be undertaken inconsiderately. It requires good light and intelligent assistants. The case which has been described occurred in the daytime; and from what was then experienced, I am disposed to think that it would not have been successfully performed by artificial light, or at least with greatly increased difficulty.'³ The difficulties which Mr. Arnott experienced were dependent, he says, on the depth of the wound, the pain and cramp on pressure of the divided muscles, and the venous hæmorrhage from concomitant wound of the *venæ comites*. Of these difficulties, Mr. Arnott rates the first as the least, and the last the greatest. The second would, of course, in the present day be avoided entirely by anæsthesia; but the third must always be anticipated in operations for wound of the artery, since the *venæ comites* are closely connected to it. Pressure in the angle of the wound from which the bleeding comes must be maintained as much as possible during the operation by the finger of an assistant. The trunk of the femoral or popliteal is of course secured by a tourniquet, unless the operator prefers Esmarch's bandage, as I certainly should. An incision is to be made, six or seven inches in length, down the middle of the calf of the leg, including the skin-wound in its centre. The gastrocnemius and soleus muscles are to be freely divided in the course of the wound, and held aside by broad retractors. Now the operator should search carefully for the deep or intermuscular fascia, immediately beneath which the posterior tibial vessels will be found. The situation from which the bleeding comes will point out whether it is the tibial or peroneal. If the latter be the artery wounded, most likely a good part of the flexor longus pollicis must be scraped off the fibula in order to find it, or (as Mr. Guthrie seems to have done) all the tissues around the bleeding point must be included in the ligature. If it be the tibial, it may be exposed with rather less difficulty; still, it is a most difficult operation, as will be evident to any reader of Mr. Arnott's account, although in that case the wound was only recently inflicted, and Mr. Arnott had able assistance at hand. In cases where much blood has been infiltrated into the leg, obscuring all the neigh-

¹ *Med.-Chir. Trans.* vol. xxix.

² I have referred (p. 92) to a case in which Mr. Annandale tied the posterior tibial and one of its *venæ comites* for arterio-venous aneurism; but in that case the sac was opened and the orifices of the wounded vessels exposed.

³ *Op. cit.* p. 51.

bouring parts, or where the surgeon is not very much versed in operations, or has to trust mainly to his own hands, it would perhaps be the better course to amputate; but I may be excused for repeating that properly-applied and carefully-graduated compresses, or the prolonged pressure of a finger in the wound, enlarged if necessary, or of hooks are recommended by Signor Vanzetti,¹ would often render either operation unnecessary. In a recent traumatic aneurism, probably one of the various methods of applying direct or indirect pressure would succeed. If any operation became necessary, most surgeons would prefer to tie the femoral artery. Others, perhaps, might treat the case, like a wounded vessel, by the old operation.

If the posterior tibial artery requires a ligature in the lower part of the leg, the operation is more simple, on account of the less depth at which it lies. An incision is to be made, about three inches in length, parallel to the inner border of the tendo Achillis, and the vessel is to be sought on the outer side of the two large tendons which pass behind the inner malleolus, that of the flexor longus digitorum being the nearest to the vessels. Behind the ankle the tendon of the flexor longus pollicis is on the opposite (external) side of the artery, but in ordinary cases will not come into view.

The *popliteal artery* has also been tied on account of subcutaneous rupture, unsuccessfully as far as the result of the case went, since gangrene set in on the third day, followed by amputation and death; but no difficulty was experienced in the operation,² which is thus described by the operator: 'Mr. Poland made an incision from seven to eight inches in length along the course of the popliteal artery, and cleared out much coagulum; and without difficulty found the ends of the ruptured artery lying an inch and a half apart; the upper end seemed to be plugged by coagulum and was secured by ligature; the lower end seemed to be patent, and was similarly ligatured. The popliteal vein was distinctly seen, and appeared to be uninjured.'³

In the 'Lancet' for August 28, 1869, will be found an interesting case in which Mr. J. D. Hill tied this artery to check the growth of an encephaloid cancer of the leg. The patient survived nearly four months, but died of hæmorrhage from the diseased tissue. The operation seems to have been unattended with difficulty, and, being performed on parts free from extravasation or swelling, was accomplished with a shorter incision than in Mr. Poland's case. Mr. Hill gives a diagram of the anastomotic circulation, which is described as being carried on 'by the anastomotica and superior internal articular arteries communicating directly with the anterior tibial recurrent, and by the descending branch of the external circumflex artery, receiving the superior external articular, and inosculating with a branch of the anterior tibial recurrent. The posterior tibial artery was supplied by the inosculation of some muscular twigs arising from either [tibial] artery, and passing across just opposite the anterior tibial recurrent. The posterior tibial was small and contracted.'

POPLITEAL ANEURISM.

Although popliteal aneurism is so frequently curable without operation, yet operations for its cure constitute the great majority of those performed for aneurism.⁵ The popliteal artery is so frequently diseased, because it is liable to strains both in flexion and (though to a much less degree) in forced extension of the joint;⁶ also because it is the end of a large tube, convex alternately forwards and backwards, which divides abruptly into much smaller branches, and is supported only by fat, while its branches plunge at once among muscles.

¹ *London Med. Record*, March 3, 1875.

² In the only two other cases, however, reported in Mr. Poland's paper, where the artery was sought for, the operation proved impracticable. The femoral artery has also been tied on account of this injury in two cases, but gangrene and death followed in both. Mr. Poland speaks in terms of merited reprobation of the practice.

³ *Guy's Hospital Reports*, 3rd series, vol. vi.

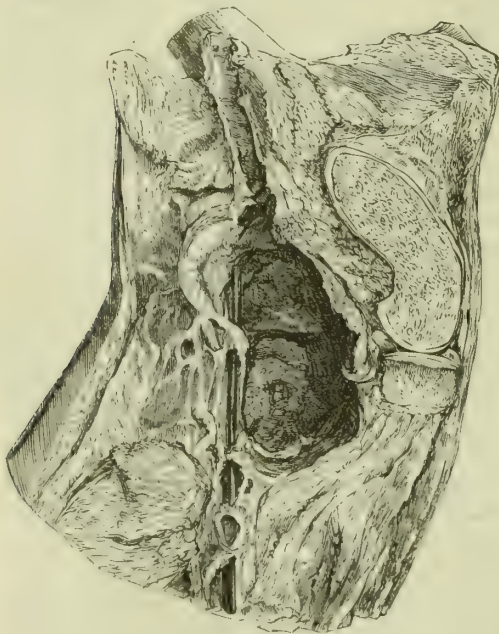
⁴ On examining the parts after the amputation, Mr. Poland found that the knee-joint had been laid open by an extensive laceration of the posterior ligament, a complication which would probably have precluded recovery even had gangrene been averted; and as this same complication was present in three cases successively admitted into Guy's Hospital (the first three in Mr. Poland's collection), the point ought to be carefully investigated during the operation of tying the artery for rupture, by passing the finger into the deep parts of the wound, when, if either condyle of the femur can be felt bare, amputation should be performed.

⁵ In the *Med. Times and Gaz.* (*supr. cit.*) seventy-five cases of ligature of large arteries are reported, of which fifty-one were of the femoral, in almost all cases for popliteal aneurism.

⁶ Very few sedentary persons or females suffer from this disease. In Norris's table, out of 155 patients, five only were females.

The symptoms of popliteal aneurism are usually quite characteristic.¹ The attention of the patient is called to the part by the tumour, or by pain and stiffness of the limb, or by the pulsation—very commonly the latter; and on examining the part the surgeon is left in no doubt of the nature of the complaint. The aneurismal bruit is usually distinct, though cases are sometimes met with in which it is absent. The feeling of the pulsation differs somewhat according as the aneurism is growing towards or away from the joint; that is, according as it is situated on the front or the back of the vessel. The more usual position appears to be at the back of the artery towards the skin of the ham; and then the pulsation is of the usual equable heaving and expansive character. But when the aneurism is growing towards the joint, and the artery therefore is raised upon its posterior surface towards the skin, the pulsation feels much more thrilling, and a distinct line of separate pulsation often marks the course of the vessel. The position of the aneurism also materially influences the probability of complications involving the joint. A large tumour rapidly growing on to the posterior ligament of the knee must cause considerable

FIG. 19.—Section of a Popliteal Aneurism. The section runs perpendicularly through the artery above; a probe marks the course of the lower part of the vessel. (Museum of Royal College of Surgeons, No. 1703.)



irritation in the joint; and synovial inflammation from this cause is a frequent accompaniment of popliteal aneurism. Still further, the resistance to the growth of the sac afforded by such firm structures as the bones and ligaments of the joint soon leads to ulceration, so that such aneurisms are liable to burst into the knee-joint; the symptoms and indications of which event have been pointed out on pp. 32, 60.

The part of the artery affected varies; but the aneurism usually presents in the middle of the popliteal space, and bulges out below either hamstring. On dissection, the opening in the artery is most commonly found near its lower end.

The ordinary relations of popliteal aneurism are well shown in a preparation by John Hunter in the Museum of the Royal College of Surgeons, of which the annexed figure is a copy.

Treatment.—The treatment of popliteal aneurism is usually successful, since such tumours partake of the nature of the milder forms of traumatic aneurism, and often occur in comparatively healthy persons. Besides, there is a long tract of artery above the tumour in the most favourable position for compression, and the anastomotic branches come off in tolerable profusion just above the tumour, and enlarge readily.

Before other severer measures are tried, genuflexion ought undoubtedly to be attempted. If bending the knee to its full extent stops the pulsation in the tumour, the best hopes may be entertained of its success. The kind of aneurism most adapted for it appears to be that which is situated on the back of the artery, and has not yet got very near the skin. In a tumour which appears on the point of bursting, it would be imprudent to insist on its trial; nor would it be likely to succeed if

¹ Further observations on the diagnosis of bursal and other tumours in the ham from aneurism will be found in the essay on DIAGNOSIS AND REGIONAL SURGERY.

the pulsation were unaffected, or even (which seems theoretically possible) increased. Pressure, instrumental or digital, on the femoral artery may succeed when flexion fails, or a combination of the two may appear more efficacious, and is easily arranged. In applying pressure, it is important to remember that the artery changes its relation to the bone in its course down the thigh, and that in order to command the circulation with the least possible force, the pad ought to be directed towards the femur. The method of applying pressure in this situation has been discussed above.

The use of Esmarch's bandage seems often advisable in combination with pressure on the femoral artery. A reference to page 74 will render further discussion of this treatment unnecessary here.

If under the use of pressure the tumour is making visible progress, the femoral artery must be tied; and this becomes still more necessary if the sac have burst; since, if the operation be delayed, the occurrence of gangrene will probably necessitate amputation.

Amputation also becomes necessary on the failure of the ligature, except in some rare cases of recurrent aneurism, when the femoral can be tied in Hunter's canal (see p. 59).

Ligature of the femoral artery.—The femoral artery may be tied at three parts of its course: (1) above the origin of the profunda; (2) at the apex or lowest point of Scarpa's triangle; (3) in the canal formed by the tendinous fibres which connect the adductor magnus with the vastus internus. Of these, the last proceeding, that originated by Hunter, is now disused, unless for exceptional cases of recurring aneurism, such as Sir A. Cooper's, above quoted; and the second is the one generally employed in popliteal aneurism; the first being reserved by most surgeons for certain cases of aneurism in the thigh, and as a preliminary to some operations.

The great advantage of Scarpa's operation, for securing the artery just as it is being crossed by the sartorius muscle, is that the vessel is exposed at a point where it is superficial, and therefore easily found; while at the same time it is far from the origin of any large branch. The operation in a natural condition of parts and a patient not very stout is usually easy. If the outline of the sartorius muscle is plainly perceptible, this will perhaps be the easiest and surest guide. Otherwise a line drawn from the centre of the fold of the groin to touch the inner border of the patella when the foot is a little abducted will mark the course of the vessel. An incision three or four inches long having been made in this direction through the skin and subcutaneous tissue (in which it will be well to avoid any large branch of the saphena vein), the fascia lata will be recognised, and should be divided on a director to the whole extent of the wound. This should expose the inner edge of the sartorius, which must otherwise be sought for by dividing the cellular tissue carefully without going deeper into the wound; and when the muscle is recognised, but not before, the sheath of the vessel is to be sought. It is generally found at once, by drawing the muscle slightly outwards, and the pulsation is felt. A nerve is usually seen in front of the artery, and must be excluded from the ligature. This may be either the internal saphenous nerve or a smaller branch of the anterior crural.¹ A small opening is to be made in the sheath, and enlarged to such an extent that the artery is fairly exposed; and then the vessel should be so far cleaned as to allow the aneurism-needle to be passed round it without material resistance. The great danger at this step of the operation is lest the vein should be injured, or should be included in the ligature. To avoid the first mistake, great gentleness is required in cleaning the artery and in passing the needle round it; while the second seems

¹ A small nerve is often seen on the front of the sheath, but the saphenous nerve itself does not come into connection with the artery so high up as the usual seat of operation. Where it is in relation with the sheath, it lies rather external to the position of the artery firmly bound down by a separate layer of fascia, which appears to form a portion of the sheath. Hence, if the sheath is opened only by a small puncture over the inner part of the vessel, the nerve will not come into sight.

impossible if the vessel have been once fairly and cleanly exposed. The position of the vein must be accurately remembered: it lies almost directly behind the artery, inclining perhaps a little to its inner side. Hence we are usually recommended to pass the needle from within outwards. This being so, if the front of the artery have been once cleanly denuded, and the point of the needle have been fairly applied to it, it seems impossible that the needle can be thrust to the deeper side of the vein, without an amount of violence which is never used on the living subject; nor can the needle even perforate the septum which separates the artery from the vein, so as to wound the latter, without more force than is justifiable. If the occurrence of venous hæmorrhage shows that the vein has been punctured,¹ the bleeding ought to be commanded by pressure, which is not difficult, and the operator must make up his mind either to abandon the operation for the time, and seek the vessel at a higher part of its course after a few days, or (which is perhaps the preferable course) to enlarge the incision upwards, and tie the artery with more care, about an inch above the spot originally selected. The ligature should on no account be tightened in the part where the needle has first wounded the vein, since in this way the thread would be left in the vein to act as a seton, and phlebitis could hardly fail to ensue, and would most likely prove fatal. If the needle have glided round the vessel without any such accident, the next step is to determine that the tissue embraced by it is really the artery, and nothing else. This is easily ascertained by pressing lightly on the tissues raised by the needle, and examining the part with the finger. The pulsation of the vessel will be felt; on making pressure, the beating of the aneurism will cease at once; while, if any doubt exists on that point, the absence of congestion shows that the vein is not included. Nothing then remains to be done except to tie the ligature firmly, and close the external wound with strapping or sutures.

In a case of ligature of the femoral artery which is to do well, the warmth of the foot, which is maintained by wrapping the limb in cotton-wool, remains slightly above that of its fellow for a few days; the patient lying quiet does not notice the numbness and partial paralysis which would no doubt manifest themselves if he tried to move about; sensation is perfect; the ligature may be expected to fall any day after the first week.²

The chief danger after the operation is from gangrene. In Dr. Norris's statistics,³ of 204 operations (for all causes), fifty died. Out of these fifty, the cause of death is not stated in four; and of the remaining forty-six, twenty-three, exactly one-half, died from gangrene, while hæmorrhage proved fatal in eight cases only; five of the remaining deaths are attributed to phlebitis, one to sloughing of the sac, and the rest to accidental causes common to all operations—tetanus, fever, hectic, pyæmia, &c.

Hæmorrhage, however, occurred in numerous cases in which it did not prove fatal, having been arrested by pressure. In order to apply pressure effectually to the femoral artery when secondary hæmorrhage takes place, a graduated compress should be fixed very carefully on the wound by means of a *presse-artère*, or the bleeding point should be commanded by the fingers of a relay of well-instructed assistants. Should these means fail to arrest the bleeding, the surgeon has the choice of three measures, viz. to re-tie the artery in the wound, to tie the external iliac, or to amputate. Amputation is, I doubt not, the safest course in most instances, but it is one which no good surgeon would willingly follow, unless the patient's general condition were very unpromising. The prospect of preservation of the limb justifies the extra risk. As to the ligature of the external iliac artery, I

¹ Slight arterial hæmorrhage is sometimes observed as the needle is passed round the artery, and stops when the ligature is tightened. It proceeds, in all probability, from the wound of a minute branch near its origin from the vessel.

² The earliest period at which the separation of the ligature has been noted in a successful case, free from hæmorrhage, appears to be the eighth day: but it rarely comes away before the eleventh. In one case it came away on the sixth day, but hæmorrhage occurred. In ninety-one cases out of 137 it separated before the twentieth day; but it has been known to remain on the vessel up to the sixtieth day.

³ *Am. Journ. Med. Sc.* Oct. 1849, n.s. vol. xviii. p. 313.

quite agree with Mr. Erichsen that it usually only adds to the danger of the case.¹ The inference would be that an attempt ought to be made to tie the artery again in the wound. If it be entirely divided, that end only which is open should be tied; otherwise a ligature should be put on it, both above and below the hole in it. If the condition of the tissues is such that the operator cannot define the vessel, or if the latter is too much disintegrated to bear the ligature, amputation should be performed, and the artery secured at a higher point, in healthy tissues.

A slight amount of gangrene is not always inconsistent with the preservation of the limb; while of the cases of more extensive gangrene, many are saved by secondary amputation. Six cases of successful amputation are recorded in Norris's table.

Porta's statistics give somewhere about the same mortality as those of Norris, *i.e.* about one-fourth; and Mr. Hutchinson more than twenty years ago published a collection of fifty-six cases in metropolitan hospitals, of which sixteen (nearly one-third) died.² It becomes, however, very important at the present day, in comparing the success of ligature of the femoral with that of pressure in the treatment of aneurism, to separate those cases in which the treatment by ligature has been uncomplicated from those in which the artery has been tied after the failure of other methods. Accordingly, in lecturing on this subject at the College of Surgeons in 1874, I produced a collection of cases in which what I called 'primary' ligature of the femoral artery had been performed during the previous ten years. The list included both provincial and metropolitan hospitals,³ and comprised, as far as could be ascertained, the entire experience of each institution.⁴ The mortality was far less than that shown by the former statistics: out of seventy-seven cases only eleven died—a mortality of one-seventh instead of one-third or one-fourth; and this comprised deaths from all causes—*e.g.* one from small-pox. Besides these cases of death, there were three instances in which the ligature failed to cure the disease, in one of which the aneurism was cured by the old operation, and in the other two the limb was amputated with success—in one case for gangrene, in the other for recurrence of the aneurism. There were only two cases of fatal secondary hæmorrhage—one fatal directly, and the other after ligature of the external iliac; and only three cases in which gangrene was noted.⁵ In no case does the sac appear to have suppurated. These facts must be allowed to be very striking, and, I own, made a deep impression on me, for I had not anticipated them; and their significance is increased by the obvious reflection that the cases in which the femoral artery was tied at once, without any previous trial of pressure, must have been the most formidable examples of the disease, and were the small minority—only seventy-seven cases out of 212. At the present time, since the introduction of antiseptics and drainage (for, of course, the cases just alluded to, with possibly the exception of one or two, were treated on the old principles), I have no doubt that the mortality is still further reduced, and that we should now see nothing exceptional in the experience of a surgeon who, like Syme, should tie the femoral artery twenty-three times in succession without a bad symptom.⁶

¹ I would refer the reader to an admirable essay by Mr. Cripps, 'On the Treatment of Secondary Hæmorrhage after Ligature of the Femoral Artery,' *St. Barth. Hosp. Reports*, vol. x. In this paper Mr. Cripps shows how much more successful graduated pressure has been in the treatment of this complication than any of the other methods. Of fourteen cases treated by ligature of the external iliac artery only two survived, and in one of these amputation had to be performed for gangrene; in the other hæmorrhage recurred, but was controlled by pressure and the patient recovered. This was the only exception to the general rule that such ligature is always followed by gangrene; and even in this case it seems probable that the secondary hæmorrhage might have been controlled at first by pressure.

² *Med. Times and Gaz.* vol. ii. (1856) p. 515; vol. i. (1860) pp. 12, 35, 62, 89, 117.

³ I may just note that the operation was quite as successful in London as in the provinces.

⁴ *Lancet*, Dec. 19, 1874.

⁵ Mr. Symonds's recent statistics from Guy's Hospital are somewhat less favourable, six deaths having occurred out of twenty operations. In two of these, however, the death was unconnected with the operation. In this series also the rarity of gangrene and the absence of suppuration in the sac are noteworthy (*Guy's Hosp. Reports*, vol. xxv.)

⁶ *Principles of Surgery*, 1856, p. 99.

It is only, therefore, in my opinion, in the simpler and more recent examples of popliteal aneurism that genuflexion, pressure, or Esmarch's bandage should be used, for in such cases measures of this kind promise speedy success, and without any impairment of the strength or nutrition of the limb. But they should not be too long persisted in, if success does not speedily follow. The doctrine which was founded on Mr. Hutchinson's statistics, that pressure, though it might not succeed, would favour the success of a subsequent ligature of the femoral, by producing enlargement of the collaterals, is, I am convinced, mistaken. Any advantage so gained is far more than balanced by the ill effects of prolonged suffering and disappointment, by the growth of the aneurism, and possibly by local lesion of the artery, vein, or surrounding tissues by the pressure. Accordingly, out of forty-four cases in the above table, in which the femoral was tied after the failure of pressure,¹ eight died, four others were amputated, and one was dismissed uncured—a much greater proportion of failures than after primary ligature. The comparison between the results of all the cases treated by compression, 124 in number, and those of the seventy-seven cases in which the ligature was resorted to at once showed that there was really but little difference, the percentage of deaths in the 124 cases was rather less, and that of failures rather more.

The total result of the treatment of popliteal aneurism in British hospitals as shown by this list was most gratifying. Out of 212 cases, seventy-seven were treated by ligature at once, 124 by pressure (with secondary ligature in forty-four), two by the old operation, seven by amputation, one by temporary ligature, and in one spontaneous cure took place. Of these, 166 were cured with preservation of the limb, twelve recovered after amputation, in four the treatment failed and nothing further was done, and thirty died.

When we recollect the great improvements which have been effected in the last few years, both in the operation of ligature and in the methods of pressure, we cannot but be gratified at the condition of this branch of surgery. At the same time, we should not forget that the necessity for the ligature depends in most cases on neglect or error in diagnosis. A small recent popliteal aneurism can generally be cured by pressure in some form, unless it be of the tubular variety and destitute of bruit, in which case the ligature will probably effect a speedy cure.

If it be necessary to tie the artery in Hunter's canal, which, however, can only be the case either for wound or after the failure of the common operation, the same line of incision will be made, but lower down; and it may be necessary to divide the muscles freely. Hence the operation is more protracted and bloody, but no important parts are endangered in either. The principal risk is of wounding the vein, or of including it or the saphenous nerve in the ligature. The edge of the sartorius is first exposed, and then, if the artery is to be taken up (as usual) in the upper part of the canal, it will be sufficient to draw the muscle outwards with a retractor; incise the anterior wall of the canal on a director, and then separate the artery carefully from the vein and nerve. In some rare cases it may be necessary to tie the artery lower down, close to the opening in the adductor magnus, when it would probably be more convenient to divide the sartorius. If this is not done, the muscle must be pulled upwards.

FEMORAL ANEURISM.

Spontaneous femoral aneurism is regarded, with reason, as a more serious affection than popliteal, since the latter often affects persons whose vascular system is in all other respects sound, while the former gives much reason to suspect a generally atheromatous condition of the vessels, in which case the existence of organic disease of the heart, or of internal aneurism, is exceedingly probable. Every such case, therefore, should be carefully examined with reference to these points before the treatment is fixed. The diagnosis of an aneurism in the thigh can hardly be attended with difficulty. Some doubt might exist as to the vessel upon which it

¹ *Lancet*, May 1, 1875.

was seated, whether the superficial or deep femoral; but the doubt would not have much effect upon treatment. In traumatic cases, the diagnosis between simple and arterio-venous aneurism should be attended to; but enough has been already said upon that point; what follows will refer entirely to the treatment of common aneurism in the thigh. Rest, without any special treatment, has been known to lead to the spontaneous cure of a femoral aneurism;¹ but it would not be good practice to delay the commencement of more active treatment beyond the day or two which is usually allowed in order to familiarise the patient's mind and body with his novel circumstances, unless the tumour were visibly decreasing in size. In all cases in which the sac has not burst, compression of the femoral in the groin ought to be tried, and will usually succeed, especially if there is opportunity for the careful application of digital compression. Nor if the sac has burst is the case by any means desperate. A careful examination will show whether pressure with the finger controls the further progress of the extravasation; if it does, compression of the femoral may be tried for a day or two, the case being, however, very carefully watched. On the failure of pressure, recourse is to be had to the Hunterian operation,² which can generally be effected below the groin, in the first part of the artery; but in cases where the tumour extends higher up, the ligature must be placed on the external iliac. The former operation will be described here, the other being appended to the section on 'Inguinal Aneurism.'

Ligature of the common femoral artery in an operation which is not generally regarded with much favour, and which is, therefore, little practised for the cure of aneurism, inasmuch as the operator generally prefers to tie the external iliac. The reason of the supposed danger of the ligature of the artery in this situation is the proximity of the ligature to large branches. The epigastric and circumflex iliac on the one side must come off near the ligature, if it is placed close to the fold of the groin; and the profunda on the other, if it is placed lower down. The neighbourhood of these large branches would certainly appear likely *à priori* to lead to secondary hæmorrhage; but some doubt is thrown upon this theoretical conclusion by the experience of the elder and younger Porter, the latter of whom reports three cases fully, and alludes to two others, in which the operation was performed by himself and his father, all of which were successful.³ Dr. Macnamara, of Dublin, in a paper published in the 'British Medical Journal,' October 5, 1867, refers to eight cases; all but two being successful. In one of the unsuccessful cases (Mr. Butcher's) the patient died from hæmorrhage, which had occurred previous to the operation; in the other (Mr. Collis's) there was a high division of the femoral; the ligature had really been placed below the bifurcation (*i.e.* it was not a case of ligature of the common femoral at all): the patient died of secondary hæmorrhage.⁴ To these cases must be added one under Dr. Gregson's care,⁵ in which the artery was much diseased. Secondary hæmorrhage took place; the external iliac artery was tied, but this did not control the bleeding; gangrene ensued, and the patient died. But this operation has not as yet been performed sufficiently often to allow of our pronouncing a confident judgment; and it must be left to the discretion of the operator to select the proceeding which he may think best calculated to save his patient's life. The ligature of the common femoral is certainly a far more easy and a less formidable operation primarily than that of the iliac. The artery can usually be felt pulsating; and nothing is necessary except to divide the soft parts over it carefully with a moderate incision, so as to apply the ligature (which should be carried from within outwards) without any exposure of the vein or other parts. The incision may be either longitudinal or transverse, and surgeons who have performed the operation

¹ Luke, in *Med. Gaz.* May 9, 1845.

² This is the ordinary rule; but in cases where there is not much ecchymosis, and in some in which the diagnosis is obscure, the old operation may be performed successfully (see the cases referred to on p. 46, note 4).

³ *Dublin Quarterly Journ. of Med. Sc.* Nov. 1860.

⁴ *New Syd. Soc. Biennial Retrospect*, 1867-8, p. 298.

⁵ *Med. Press and Circular*, Sept. 2, 1868.

differ as to the relative advantages of the two incisions. The crural branch of the genito-crural or a small branch of the anterior crural nerve may be found running down in front of the vessel, but can be easily avoided.

Another objection to which the ligature of the common femoral is exposed is the liability to gangrene, in consequence of the vessel being blocked up above the origin of both of the great nutrient arteries of the limb. The superficial femoral, which nourishes the lower part of the limb, is comparatively easily reinforced after the ligature by its free anastomosis with the profunda artery; but when both these channels are blocked up, the consequent strain upon the collateral circulation is much increased; and, for my own part, I must express my decided preference for the ordinary operation whenever there is a choice between the two. Yet, if the aneurism were seated in the thigh, and the ordinary operation were impracticable, I should prefer the ligature of the common femoral to that of the external iliac.¹

In Norris's table, above referred to, the femoral artery was tied twenty-seven times for aneurism in the thigh, with only five deaths; a smaller proportion than that of ligature of the femoral from all causes. Unfortunately, it is not told us in how many of these cases the artery was exposed above the origin of the profunda; which must, I presume, have been the case in some if not in most of them. The omission in so careful a compilation is doubtless due to the inadequacy of the original notes. In Porta's table, eight are said to have died out of sixteen; but no details are given.²

INGUINAL ANEURISM.

Pulsating tumours are always to be viewed with some suspicion when they lie in close proximity to any bone possessing a copious diploë. Hence such affections about any part of the pelvis should always be very carefully examined before they are pronounced aneurismal. The records of surgery abound in instances of tumours in the gluteal and abdominal regions having been pronounced to be aneurism of the large arteries of those parts, when they were really pulsating cancers of the bone; and many of the cases reported by the older surgeons were obviously of this nature, though the mistake was never discovered, and they stand amongst the list of aneurisms. Such a mistake is less likely to occur in the groin than about other parts of the pelvis; but the surgeon should be on his guard here also. A comparison of the pulse in the chief arteries of the two limbs will be of great service, since it is usually altered in aneurism and not in the pulsatile tumour; and the other points of the diagnosis between aneurism and pulsatile tumour should be carefully examined (see p. 44).

The diagnosis having been made, the question will occur whether the case is a fit one for compression, or whether the Hunterian operation must be performed. Compression on the external iliac, in persons not very fat, can be easily applied by the finger; and numerous instances of the success of digital pressure in this region are recorded. In the face of such facts, no surgeon would be doing his duty who exposed his patient to the great risks of an operation on the external iliac artery, without a well-considered and persevering attempt to cure the disease by pressure, whether digital or instrumental. In these aneurisms complete pressure, both proximal and distal, by means of a tourniquet applied to the artery above and

¹ In the year 1868 a patient was under my care in St. George's Hospital, in whom Mr. Smyly, of Dublin, had tied the common femoral artery for the cure of popliteal aneurism in the groin. The operation had been perfectly successful as far as the cure of the aneurism went: in fact, the latter was no longer perceptible. But the patient had lost the second and third toes from gangrene, as well as some of the skin at the inner side of the foot; and the cicatrix had ever since been so unsound that it broke down into a torpid ulcer on any slight cause. This had been a source of constant misery and loss of activity to him ever since the operation. I should, however, add that there had been some ulceration of this foot and leg before the femoral was tied.

² Further details on the subject of the ligature of the common femoral artery will be found in a lecture by me, published in the *Lancet*, Aug. 29, 1874, p. 299, and in Mr. O. Pemberton's *Address in Surgery*, 1872, p. 8.

another below the tumour, has been found extremely successful. The patient should be confined to bed for a few days, while the instruments are being got ready—for it is necessary to see that the compressors fit very accurately—and during this interval the way may be prepared by the application of digital pressure for the more serious endeavour to cure the disease. Then ether or chloroform should be administered, and the patient should be kept under its influence for the necessary length of time, whilst all circulation is suspended in the sac by pressure on the external or, if necessary, the common iliac above and on the femoral below.

An instance of cure of inguinal aneurism by this means is recorded by Dr. Mapother,¹ in which the pressure was applied on the first occasion for seven, and on the second for twelve hours; and instances of cure by long-continued compression between the heart and the aneurism only by Mr. Eck,² Mr. Lawson,³ Mr. Hilton,⁴ and others. In the last-named case there was also popliteal aneurism, which was simultaneously cured. I am informed, however, that in this last case the cure was not permanent in the popliteal aneurism, and the limb was afterwards amputated in the country.

It is possible, also, that direct pressure upon the tumour may assist in the cure, as it seems to have done in Mr. Luke's case, above referred to; but this should be used very cautiously, since sloughing of the coverings of the tumour would most seriously complicate the case. A most interesting case of cure of a large femoral aneurism by direct pressure is related on p. 67.

Ligature of the external iliac artery.—The operation for securing the external iliac artery is usually regarded as a very successful one; and relatively to the other operations on large trunk vessels it may be so considered; still the mortality among the cases hitherto published has been very great. Of 153 cases, taken indiscriminately, forty-seven died; a mortality exceeding that of amputation of the thigh.

The operation is performed by making a sufficient incision through the parietes of the lower part of the abdomen, the precise direction of which is not a matter of very great consequence, but which is usually drawn from a little above the centre of Poupart's ligament outwards (so as to avoid the direction of the epigastric artery) to a little internal to the anterior superior spine, from which point it may be curved inwards, as far as may be thought necessary, towards the umbilicus; or it may lie directly over the course of the artery. The muscles are to be divided to the same extent, care being taken in dividing the lower strata, until the transversalis fascia is reached. This structure can generally be recognised immediately beneath the muscles, and should be divided in the iliac fossa, not far from the anterior superior spine, upon a director, after a hole has been cautiously made in it. The operator will now find a cellular interval lying above the peritonæum; and that membrane, with the intestines, should be gently and gradually pushed over towards the middle line, until the vessels are seen or felt. The vein, it should be remembered, lies internal to the artery; and the genito-crural nerve, or lower down its genital branch, lies on the anterior surface of the vessel. The ligature must therefore be passed from within outwards; and if the nerve have been included in it, care should be taken to slip the thread away from under it before the knot is tied. The ligature of this little nerve need not, however, lead to any bad results. The accident which usually happens in this operation is, naturally, the laceration of the peritonæum. It is not necessarily attended with fatal or even serious consequences; in fact, a successful case is recorded in which the peritonæum had been divided by mistake for the transversalis fascia, to the extent of the external wound; but any injury to the peritonæum should nevertheless be most carefully avoided.

In principle, the various operations described on the iliac arteries reduce themselves to two methods, in one of which the artery is reached from below, while in the other it is approached from without or from above, as has been just described. The latter method is easier when the aneurism encroaches upon Poupart's ligament; the former when the tumour is situated

¹ *Dublin Med. Press*, March 29, 1865.

² *St. Barth. Hosp. Reports*, ii. 190.

³ *Lancet*, October 26, 1867.

⁴ *Med.-Chir. Trans.* vol. lii. p. 309.

lower down, and the whole of the artery may, therefore, be expected to be found healthy. There is little difference between the two plans, except that the operation from below requires a smaller incision, and is less difficult in appropriate cases; but if the artery be pressed back into the pelvis by a tumour extending up into the groin, it becomes much more difficult, if not impracticable, from adhesion between the tumour and the peritonæum. Sir A. Cooper, in describing the operation from below, advises that 'the centre of the internal oblique and transversalis muscles should be raised from Poupart's ligament. The opening by which the spermatic cord quits the abdomen is thus exposed, and the finger passed through this space is directly applied upon the iliac artery.' The rest of the operation then consists chiefly in scratching the fascia off the artery, separating the latter from the vein and passing the ligature round it, which Sir A. Cooper directs to be done from without. Mr. Guthrie, however, justly observes that the vein is less likely to be injured if the point of the needle be first insinuated between it and the artery, and the ligature carried from within outwards.¹

The points to be chiefly guarded against in the ligature of the external iliac artery are, wound of the epigastric artery, of the vas deferens, or other constituents of the spermatic cord, laceration of the peritonæum, puncture of the external iliac vein or of the circumflex vein, ligature of the genito-crural nerve, and a too free disturbance of the subperitoneal cellular tissue. The wound of the epigastric artery is only probable when the operation is practised from below. The vessel can, it is true, be secured, but the bleeding and loss of time are objectionable; and after it is tied an important anastomosis is stopped up, and the chance of gangrene increased. The vas deferens also is only endangered in tracing the artery upwards. A knowledge of its position, and its peculiar cord-like feeling, will suffice to make the operator avoid it. The laceration of the peritonæum cannot always be avoided. Great gentleness should be used; and before the operation the patient should have been well purged, in order to obviate any distension of the intestines. The clean exposure of the artery is the best safeguard against wounding the vein or including the nerve. The circumflex iliac vein which crosses the end of the artery must be avoided in the operation from below. A careful selection of the method most appropriate to the case before him will enable the operator to reach the artery with the least possible disturbance of the deep cellular tissue. It is true that it may become absolutely necessary to disturb a large extent of the peritonæum from its cellular connections; but this should always be avoided as far as possible, since it greatly increases the risk of diffuse inflammation on one or the other side of the serous membrane.

In Norris's and Cutter's tables² of 153 cases of ligature of this artery for all causes, forty-seven died; out of these the cause of death is not stated in one, was doubtful in one, and in two was unconnected with the operation; of the remaining forty-three, seventeen died of gangrene, and three of sloughing of the sac, nine of hæmorrhage, five of peritonitis, one of pelvic abscess, one of diffuse inflammation, three of prostration and exhaustion, one of pleurisy, two of tetanus, and one of delirium tremens. Two of the remaining cases were unaccounted for. In successful cases, the earliest period of the separation of the ligature was the tenth, the latest the sixty-second day. In fifty-two cases it came away before the twentieth day, and in thirty others before the thirtieth.³

ABDOMINAL ANEURISM.

Many of the pulsating tumours which are found in the false pelvis are of a cancerous nature; many of those which are undoubtedly aneurismal are seated upon the aorta, too high for surgical treatment. Thus, both the diagnosis and treatment of such tumours demand the most careful consideration. I can add nothing on the

¹ Guthrie's *Commentaries*, p. 268.

² *Am. Journ. Med. Sc.* vol. xiii. (1847) p. 13; vol. xlviii. (1864) p. 36. There seems an error in Dr. Cutter's statement of his results. He tabulates fourteen deaths, but only reckons thirteen.

³ A successful case of ligature of the external iliac with silver wire has been recorded by Dr. Martin in the *Am. Journ. of Med. Sc.* Oct. 1866, p. 580. The iliac arteries (external or common) seem to me peculiarly appropriate for the animal ligatures which have lately been introduced into practice by Mr. Barwell and others. See a case reported by me in the *St. George's Hosp. Reports*, vol. x. p. 483, and Barwell, *On Aneurism*, p. 13.

general question of the diagnosis between aneurism and pulsatile tumour of bone to what will be found above; and will here merely remark that the points most likely to be marked as distinguishing a tumour of the os innominatum from an aneurism of the iliac or gluteal artery would be the presence of swelling on both sides of the bone, and the appearance of cancer-cells in the urine, together with the equal beat of the pulse on the two sides. It would never be agreeable or advisable to commence an operation on the iliac vessels without having plainly heard the aneurismal bruit. But Mr. Moore's case of ligature of the common iliac artery for a supposed aneurism, which proved to be a mass of cancerous glands pressing on all three iliac arteries, shows that even this symptom may be deceptive.¹

As to the treatment of an aneurism in the belly, three plans suggest themselves: the employment of compression to the artery above, the use of medical means only, or the Hunterian operation.²

The successful treatment of abdominal aneurism by compression was first carried out by Dr. Murray, of Newcastle-upon-Tyne,³ under chloroform; pressure being kept up on the first occasion for two hours and on the second for five hours, with permanent success. In a case under the care of Dr. Heath, of Sunderland,⁴ pressure had been kept up irregularly for ten hours, when the patient fainted under chloroform. The symptoms were as bad as ever. He was urged to bear a final effort without chloroform. This he did, and at the end of twenty minutes, when he declared he could bear it no longer, the aneurism had become solid and had ceased to beat.

In the year 1874 I produced at the College of Surgeons⁵ a table of all the cases which I could then find, in which rapid pressure had been applied with a view of curing the aneurism at a single sitting—an attempt which, in many of them, was repeated at subsequent sittings with varying success. In six of these the aneurism was, or was diagnosed as being, aortic. The fact was ascertained in four by post-mortem examination (in one of which the aneurism was chiefly of the superior mesenteric, though extending from the aorta); and in the other two there seems no reason to question the diagnosis. Of these, three were successful, two were fatal, and in the sixth the attempt was abandoned before fatal injury had been inflicted. In ten the aneurism was iliac, or ilio-femoral; seven were cured. In the other three the attempt failed, and all the patients died after ligature of the vessel, which in one case was the aorta.

The dangers which are incidental to the compression of the arteries of the belly are, first, those attending prolonged anæsthesia; secondly, the risk of peritonitis from irritation of the peritonæum, either covering the bowels or the mesentery; and thirdly, contusion of the pancreas, kidney, or other viscera. The operation is both a difficult and a very dangerous one, but its danger is very much less than that of ligature of the aorta, or even of the common iliac. I am not at all sure, however, that the ligature of the external iliac, when this is possible, is not a less dangerous measure, and it is certainly far more certain in its action.

The Hunterian operation for abdominal aneurism may be practised on the common iliac artery, or on the lower part of the aorta. In some cases it may perhaps be possible to secure the upper part of the external iliac for aneurism situated above the groin; but this operation has been already described.

The operations for securing all the iliac arteries are similar in principle, and identical in most of their details. The same incision serves to reach them all—only to reach the common or internal iliac the incision must extend further upwards, and must be longer, in consequence of the greater depth at which the internal iliac lies, and the higher position of the common iliac. Hence the surgeon can determine during the operation which vessel he will select, according to the extent of the tumour and the appearance of the artery when exposed.⁶

In applying a ligature to the *common iliac*, the operator must remember the situation of the large veins which run with the artery of each side; and he must be

¹ *Med.-Chir. Trans.* vol. xxxv. p. 468.

² The old method has been adopted here also; but its results, I believe, have been, and would always be, uniformly fatal.

³ *Med.-Chir. Trans.* vol. xlvii. p. 187. Dr. Murray speaks of the experiment of curing abdominal aneurism by pressure as one previously unthought of—not having met with the recommendation of the plan in the first edition of this work.

⁴ *Brit. Med. Journal*, Oct. 5, 1867.

⁵ *Lancet*, Oct. 10, 1874.

⁶ Guthrie, *Commentaries*, p. 262.

careful to look out for the ureter, both to avoid including it in the ligature (of which, however, there is little risk), and to avoid doing it any other damage.

The common iliac may also be tied by an operation behind the peritonæum similar to that which is used in experimental operations on the lower animals for tying the abdominal aorta.

Sir P. Crampton's case is well known, and his operation is a good illustration of the method of reaching the artery from above the tumour. An incision was made from the end of the last rib obliquely forwards and downwards to the crista ili, and then curved forwards above and parallel to the crest of the ilium, terminating at the anterior superior spine. The muscles and fascia transversalis were cut through at the bottom of the incision till the subperitoneal interval was reached, and then the peritonæum being held back by the front of the finger, a probe-pointed bistoury was run along the back of the finger, and so, by repeated strokes of the bistoury, the muscles were divided to the extent of the external wound. Sufficient room was thus obtained to pass in the whole hand, and raise the peritonæum and intestines from the fascia iliaca. The parts were then plainly visible, and the vessel easily secured.¹

In the 'Am. Journ. Med. Sc.,' April 1881, a most interesting case is related, in which a large aneurism had greatly displaced the iliac arteries. Prof. Sands, of New York, tied the left common iliac artery by an incision through the peritoneal cavity, similar to Sir A. Cooper's operation on the abdominal aorta. The operation was entirely successful, and the patient recovered, though after amputation of the leg for gangrene. This plan, however, should never be followed if either of the others are practicable.

The statistics of the ligature of this great vessel are most gloomy, the recoveries having been only exceptional. In the 'Am. Journ. of Med. Sc.' for July 1860, Dr. Stephen Smith collected all the cases known then to have occurred, thirty-two in number,² of which only seven terminated in recovery; and in one case at least the patient appears to have died under the operation. The causes of death were noted in nineteen cases; and it is remarkable that gangrene was the alleged cause in only three instances; the others were, 'exhaustion' eight, hæmorrhage six, and peritonitis two. In successful cases, or cases uncomplicated by hæmorrhage, the ligature may be expected to separate in about three weeks.³

Ligature of the abdominal aorta.—Sir A. Cooper's case, the first in which the abdominal aorta has been tied, is well known.⁴ The patient was suffering from

¹ It is worth while to quote Sir P. Crampton's forcible description. 'The parts were unobscured by a single drop of blood. There lay the great iliac artery, nearly as large as my finger, beating awfully, at the rate of 120 in a minute, its yellowish-white coat contrasting strongly with the dark blue of the iliac vein which lay beside it, and seemed nearly double its size. The ureter, in its course to the bladder, lay like a white tape across the artery; but in the process of separating the peritonæum, it was raised with that membrane, to which it remained attached' (*Med.-Chir. Trans.* vol. xvi. p. 162).

² Dr. Smith has divided his cases into four groups: 1, for arrest of hæmorrhage in wounds, or in surgical operations, eleven cases, only one of which recovered; 2, for aneurism, fifteen cases, ten deaths; 3, for pulsating tumour mistaken for aneurism, four cases, one recovery; 4, to obviate hæmorrhage in an operation in one case, and in an aneurism for anastomosis in the second, two cases, both of which died. It is perhaps hardly presumptuous to say, after this experience of the operation, that most of the cases never ought to have been submitted to ligature; and that the operations in the first class would now be unjustifiable.

³ I have little doubt that in future the ligature of the common iliac artery will be rendered much less fatal by the use of antiseptics and drainage, and by the employment of animal ligatures. In the only case in which I have myself performed the Hunterian operation for ilio-femoral aneurism, the artery was situated so deeply that it was impossible to expose enough of it to see whether it was the common or external iliac. My impression was that it was the external, though in the situation of the common, *i.e.* that the common iliac had bifurcated higher than usual. I used Mr. Barwell's ligature made of the ox's aorta, and nothing could have done better, as far as everything connected with the ligature went. Gangrene had commenced in the foot and leg before the operation. An unsuccessful attempt had been made to cure the aneurism by rapid pressure on the common iliac (*St. George's Hosp. Reports*, vol. x. p. 483).

⁴ *Surgical Essays*, by Cooper and Travers, vol. i. p. 128.

aneurism, which appears to have involved the left common iliac artery, and the vessel below it to some extent. It had burst through the skin, and the patient was greatly reduced by hæmorrhage. Sir A. Cooper endeavoured, by making a small puncture into the aneurism which he could plug with his finger, to reach the opening of the artery, with a view of tying it on both sides of its communication with the sac—the operation since practised by Mr. Syme. But as he could not reach the vessel by this means, he determined to give the patient the ‘only hope of safety’ which remained for him, by putting a ligature round the artery above the tumour—the aorta. The operation was accomplished by an incision through the linea alba three inches in length, its centre corresponding to the umbilicus; the peritonæum was opened to about the extent of the skin-wound; the intestines, which were completely empty,¹ did not protrude; the finger was passed down between their convolutions on to the spine, where the aorta was felt beating violently. The peritonæum was then scratched through with the finger-nail, and the point of the finger was insinuated below the vessel. The aneurism-needle was then conveyed round the aorta, and the ligature tied. In doing this, great care was necessary to avoid including the intestine or omentum. Sir A. Cooper’s patient survived forty hours; Mr. James’s died the same evening. These cases, to say nothing of the numerous instances in which the artery has been successfully tied in the lower animals, certainly show the possibility of survival after the operation; and accordingly the operation has been repeated several times,² not, however, on Sir Astley Cooper’s plan, but by an operation similar in most respects to Sir P. Crampton’s on the common iliac artery; that is to say, by a free incision through the abdominal walls, somewhat far back, carried down to the fascia lining them, then making a cautious division of this fascia to the extent of the wound, gradually pushing over the peritonæum and intestines, and directing the fingers towards the front of the spine, where the pulsation of the great artery will easily be felt. But though it is easy to feel the artery, there is much difficulty in getting the finger round it, and in separating it from the important parts which lie around.

Many most interesting questions present themselves in considering the justifiability of this daring experiment in operative surgery. Our space will not allow of their adequate discussion; but the main considerations must be summarily stated. First, is there really any rational prospect of recovery? One of the patients (Monteiro’s) survived ten days, so that it would be rash to deny that there is. Still we must not forget that such an operation is never undertaken except upon a patient in the extremity of a disease probably affecting the whole arterial circulation, one in a very different condition from a healthy animal, or even a healthy man. Secondly, allowing the theoretical possibility of recovering, is the practical chance of it ever equal to that of spontaneous cure? Sir A. Cooper’s case certainly was one, to judge by his description, in which such a cure was impossible, since he had laid open the tumour in an unsuccessful attempt to perform the old operation; and hæmorrhage must soon have occurred, and could hardly have failed to prove instantly fatal, so that some operation was inevitable. But, thirdly, is it ever necessary to secure the aorta itself? Mr. Guthrie believes, on the contrary, that when an operation is possible, the common iliac artery above the tumour could always be reached by making the incision on the opposite (sound) side, as if to tie the common iliac on that side, and then passing over from that artery, when it has been found, to the one on the side of the disease.³ The old operation might be attempted, but would be very liable to fail, from the fact of the sac passing into the pelvis, and so perhaps pressing the opening of the artery out of sight; or galvano-puncture might be tried in a case

¹ Sir A. Cooper adds the remark, that in this operation it is essential to have the bowels well emptied; and the truth of this observation was exemplified in the next case in which the artery was tied, by the great trouble experienced by the operator (Mr. James) in consequence of the tympanitic condition of the intestines (*Med.-Chir. Trans.* vol. xvi. p. 1).

² By Murray, *Med. Gaz.* 1834, vol. xiv. p. 68; Monteiro, *Schmidt’s Jahrb.* 1843; South, *Lancet*, 1856, vol. ii. p. 222; McGuire, *Am. Journ. of Med. Sc.* Oct. 1868, p. 415; and with a temporary compressor by Mr. Stokes, of Dublin (see page 61, note 2).

³ *Commentaries*, p. 265.

which seemed suitable for it. In such desperate circumstances probably any treatment would be unavailing to prolong life; but the risk of doing harm by any treatment is not great, since the patient's life will not last under any circumstances more than a few days. On the whole, however, the natural repugnance of surgeons to perform great operations which cannot be expected to succeed, will either banish this altogether from practice, or restrict it to a very few exceptional cases.

GLUTEAL ANEURISM.

Pulsating tumours in the buttock, of spontaneous origin, are usually found to be of a cancerous nature, and connected with the innominate bone; but aneurism of the gluteal or sciatic artery may occur unconnected with wound, and in the Museum of the College of Surgeons there is a preparation by John Hunter of an aneurism of the internal pudic artery. The diagnosis, however, should be very clearly established before the extremely dangerous measures necessary for the treatment of gluteal aneurism are recommended. The points to which principal attention would be directed would be, whether any tumour is present in the iliac fossa; or can be felt in the pelvis from the rectum or vagina; whether the bruit is of the true aneurismal character; whether any bone can be felt in the envelope of the tumour; whether the pulsation resembles that of aneurism (expansive) or that of pulsatile tumour (rapid and heaving); and, finally, whether any sign of constitutional affection can be detected. Mr. Guthrie's case,¹ however, shows that the greatest experience in aneurism cannot always insure against errors of diagnosis.

If the existence of aneurism appears certain, the surgeon has the choice of a great variety of methods of treatment: pressure on the aorta or common iliac from the abdominal wall; pressure on the artery leading to the aneurism, carried on from the rectum; coagulating injection; galvano-puncture; the old operation by laying open the sac; ligature of the artery leading to the tumour, after the method of Anel; or the Hunterian operation applied to the internal iliac, or even to the common iliac.

The affection is so very rare that it is hardly worth while to spend much space on it in a work of this character. I would refer to a lecture published in the '*Lancet*' for July 11 and 18, 1874, for the literature of the subject up to that period, and for the evidence which led me to the following conclusions: viz., that

1. Gluteal aneurisms, both traumatic and spontaneous, are very favourably circumstanced for the treatment by either rapid or gradual compression, applied to the aorta or common iliac.

2. If this treatment does not succeed by itself, it may be supplemented by coagulating injection or galvano-puncture, performed while the patient is narcotised and the circulation commanded.

3. When such treatment fails, and particularly in aneurisms with imperfect or ruptured sacs, where it is not indicated, the internal iliac must be tied when the surgeon thinks that he cannot find the artery outside the pelvis. But when the artery is accessible, the old operation, or the operation of Anel, should be practised, according to the size and extent of the tumour.

4. The ligature of the internal iliac artery is liable to failure in cases of spontaneous aneurism from a diseased condition of the coats of the artery, and should always be avoided when other means of treatment are available.

I have only to add that since that time a very interesting case published by Dr. Sands, of New York,² has shown the possibility in some cases of making pressure on the artery above the tumour from the rectum for a considerable time, though it is true that in the instance in question no effect was produced.

It remains only to describe the operation for ligature of the internal iliac artery. The internal iliac should only be tied for aneurism of one of its branches, or for a wound within the pelvis in which pressure will not stop the bleeding. In this case, however, the operation, which is one in itself of great danger, should be practised

¹ *Med.-Chir. Trans.* vol. xxviii. p. 308.

² *Am. Journ. Med. Sc.* April 1881.

only after very careful deliberation. The artery has been secured in order to stop hæmorrhage from a wound in the buttock; but the practice has been justly censured by Mr. Guthrie.¹

The operation much resembles that above described for placing a ligature on the common iliac (see p. 145). Having, by the steps there prescribed, arrived at the lowest point, or bifurcation, of the common iliac artery, the operator must follow down the internal iliac into the pelvis, his finger being laid across the external iliac vessels, which may, if it be practicable, be shielded by a curved spatula from all chance of injury. It is desirable to place the ligature at a distance of about $\frac{1}{2}$ – $\frac{3}{4}$ inch below the bifurcation. The vein lies behind the artery. The spot at which the ligature is to be placed having been fixed, the surgeon scratches the artery free from its connections with his finger-nail, and then proceeds to pass the ligature; in doing which Mr. Guthrie says that it is desirable if possible to see the vessel, and for this purpose directs that the lips of the wound be retracted. The artery, however, lies at so great a depth that it can only be brought into view if the person be spare. Great care accordingly is required to avoid wounding the peritonæum, the ureter, and the vein which accompanies the artery. The termination also of the inferior mesenteric vessels (superior hæmorrhoidal) may be injured in operating on the artery of the left side.

The cases in which this operation is required must be very rare. In the Lectures above referred to twelve cases are enumerated in which the internal iliac was tied for aneurism, of which five died.

T. HOLMES.²

¹ *Commentaries*, p. 270.

² In the first edition the Sections on Digital Pressure, Manipulation, Galvano-puncture, Coagulating Injections, Arterio-venous Aneurism, and Cirroid Aneurism, were written by Mr. Hart.

DISEASES OF THE VEINS.¹

JOHAN HUNTER was the first to describe inflammation of the lining membrane of veins. Aretæus² had long before referred to some such disorder; but the disease he told of was so ill defined that no one profited or sought to advance his crude idea. Century after century surgeons continued to puncture, divide, and excise veins, fearless of the result and innocent of their inflammation. Troublesome symptoms, it is true, sometimes followed these operations; but they were referred to nerves, tendons, or fasciæ—anything rather than the veins—to nerves more especially.

‘I was called in haste,’ says Ambroise Paré,³ ‘to see his Majesty.’³ He had been let blood by a surgeon, and a nerve had been wounded in performing the operation, at which the king cried out with pain. The arm became contracted, and the pain diffused throughout the entire limb. I applied a plaster over the wound to assure its closing, and bathed the part with warm turpentine and spirits of wine to allay the irritation, the arm being bandaged to the shoulder, and after a time the symptoms began to abate.’

Gangrene, he further states, may attack an arm after venesection, and may prove mortal. ‘I have known a lady to die,’ writes Dionis, ‘from diffused inflammation of the limb after a bleeding from the foot.’

The older writers, Paré,⁴ Petit,⁵ Haller, Morgagni, &c., speak of the clots or ‘polypi’ to be found in the venous system; and Meckel, Frank, Sasse, and more particularly Gendrin,⁶ followed Hunter in describing inflammation of the inner coat of veins. Gendrin’s description may be summarised thus: the inner and middle coats are thickened and reddened by inflammation, the inner coat is more loosely adherent to the middle than in health, lymph is exuded on the lining membrane, the blood in the vessel coagulates; and so the vein is filled, partly with lymph and partly with clots. Then, as in every other inflammation, the mingled products undergo further changes.

Later pathologists, however, have doubted how far the staining of the lining membrane and the obstruction of the vein with clot was really due to inflammation.

The experience of Guthrie,⁷ who doubts the existence of an adhesive, or, as he terms it, a healthy inflammation of veins, is opposed to Gendrin’s description; and Travers⁸ concludes that ‘the internal coat of a vein is, when compared with an artery, difficultly susceptible of adhesive inflammation. Indeed, the process of healing and division by ulceration seems to be conducted without any sign of inflammatory action; but the indisposition of the venous membrane to inflame is not, as appears to me, inconsistent with its tendency, under adequate excitement, to

¹ In revising this article of my deceased friend, I have put all the statements which rest on his authority under his name, and am personally responsible for those which stand in the first person.—T. HOLMES.

² Κεφ. η'. Περὶ τῆς κατὰ τὴν κοίλῃν φλέβα ὀξείης νόσου. Sydenham edition, London, 1856.

³ Charles IX. of France.

⁴ *Œuvres complètes d'Ambroise Paré*, par J. F. Malgaigne, tome ii. pp. 268 et seq.

⁵ ‘Sitôt que le tronc des vaisseaux est entièrement bouché par le premier caillot, le sang qui remonte par les branches se coagule à mesure qu’il arrive, la tumeur augmente et devient plus dure.’ He then describes softening of the tumour thus indurated, which he ascribes to separation of serum from the clot: ‘c’est cette sérosité qui fait la mollesse’ (*Traité des Maladies chir.* tome ii. p. 42).

⁶ *Histoire anatomique des Inflammations*, tome ii. p. 16.

⁷ *A Treatise on Gunshot Wounds*, 3rd edit. p. 299.

⁸ *Surgical Essays*, part i. p. 255.

inordinate and excessive inflammation. It is not unusual to find the morbid action of parts that are difficultly roused least controllable when once set up.'

Cruveilhier¹ observed that vascularity was not seen in the lining membrane of veins, even when the blood charged with irritants from inflamed parts caused an inflammation; for 'I do not regard the phlebitis as the first change, but consider the coagulation as anterior to the phlebitis.' Hunter² thought it difficult to conceive 'how adhesions should take place on the internal surface of veins; since it is most obvious that the coagulable lymph thrown out by the exhalants on the internal surface of the vein, mixing with the same fluid circulating with the other parts of the blood, would be swept away without producing any effect. But since such adhesions do in fact happen, the coagulable lymph must undergo some change connected with the disposition which produces its extravasation.'

Travers was the first to show that veins, after ligature or division, repair without an adhesive inflammation. Three preparations illustrate this fact. One, in the Museum of St. Thomas's Hospital,³ is thus described: 'Appearance of a vein divided by the ligature, which came away on the twenty-fifth day. The upper part of the vein is filled with firm layers of coagula, which so tenaciously adhered to the inner membrane as to be separated with difficulty; when separated, the surface was found to be perfectly smooth and natural.'⁴ The second preparation shows the result of a ligature applied to the jugular vein of a horse for twenty-four hours. The inner vein-wall, thrown into longitudinal folds, is otherwise natural in appearance, whilst a good deal of lymph is accumulated externally around the ligature. The third, which, with the preceding, is in the Museum of St. George's Hospital,⁵ shows the effect of a ligature, including part of the parietes of the jugular vein of a horse. Some fibrine is deposited in the track of the thread and in a small pouch below, but no evidence exists of any inflammation of the lining membrane, and this three days after application of the ligature.

Experiments made on animals used to be appealed to, as proving that in inflamed blood-vessels, the lymph found in their interior is secreted by the lining membrane. Thus Gendrin, having secured a portion of an artery between two ligatures, and entirely cleansed it of blood, discovered, after throwing in an irritant injection, a plastic membrane deposited within the part so insulated, filling up the whole calibre of the vessel; and he affirms that similar results followed in experiments upon veins. Notwithstanding the credit this view long obtained, and the support it received from authorities in this country and abroad, its accuracy was disproved by Lee. Having found that inflammation of the coats of the veins only occurred when the blood had previously coagulated in them, he was induced to believe that the deposit found in the veins might be derived directly from the blood. Gendrin's experiment was, therefore, repeated; and when precautions were taken to exclude all blood from the vessel, no lymph was effused in the vein.

In repeating this experiment, Mr. Callender observed, however, that lymph is occasionally found within the veins, but that its presence is due to an effusion external to the vessel. The precaution of closing, by ligature or otherwise, the opening through which the irritants are introduced, effectually secures its absence. The following experiments show the result as this precaution is, or is not, taken. They show that the lymph, when present, finds its way into the vein from without, and is not exuded from or through the lining membrane. Neither, in animals, does the internal coat inflame when irritated.

1. Part of the femoral vein of a dog being selected, free from anastomosing branches, a ligature was applied so as to stop the blood coming from the extremity. The vein was then opened by a longitudinal incision, and the blood in the vessel was removed. A second ligature was then applied between the longitudinal cut and the first ligature, and a third was tied between the wound and the heart. After twenty-four hours, lymph was found in the latter inter-

¹ *Traité d'Anatomie pathologique générale*, tome i. p. 290.

² Hunter, *Works*, vol. iii. p. 582.

⁴ Travers, *Surgical Essays*, plate xiii.

³ Series v, 151.

⁵ Series vi. 173, 193.

space, but not in the first. There was also an abundant deposit of lymph external to the vessel.

2. Part of the femoral vein of a dog having been included between two ligatures, was punctured, all blood removed from its interior, and two small pieces of lead introduced within the portion of the vessel isolated by the ligatures. Twenty-four hours after the operation the vein was surrounded by lymph, a considerable quantity of which had entered the vessel through the puncture distending its canal, as may be seen in the preparation.

3. The femoral vein of a dog having been exposed, an experiment was made which resembled the preceding; but the ligature nearer the heart was shifted after introduction of the foreign bodies so as to cut off the portion of vein in which the pieces of lead were included from communication with the puncture in the wall of the vessel. The lining membrane of the portion of vein thus isolated presented a natural appearance twenty-four hours after the operation.

4. A small piece of lead was introduced within the femoral vein of a dog, and there suspended by a thread, as seen in the preparation. The puncture in the vein-wall was then closed by a ligature, which had the effect of slightly narrowing the canal of the vessel. The blood was then allowed to flow through the vein for forty hours. At the end of this time the lining membrane of the vessel retained its natural appearance.¹

From these considerations it is manifest that adhesive phlebitis has been very variously described and accounted for, and that its occurrence has been denied by some pathologists. There can be no doubt but that veins are repaired without its aid, and experiments upon animals, taken for what they are worth, show that the lining membrane of these vessels does not inflame when irritated. Absence of vessels from this membrane points, one would think, a reason for its immunity. A tissue thus circumstanced may eventually be involved when adjacent parts are affected, but it rarely originates disease. As the barrier between tissues often inflamed on the one hand, and the blood-stream on the other, it would obviously discharge an important function did it prevent lymph from being effused on the internal surface of the vein. For, although this lymph might be swept away without producing any local effect, it could not be mingled with the blood without risk of spoiling that fluid, or of causing secondary mischief by becoming entangled in, and so obstructing, the capillary vessels.

It seems better, therefore, to consider what has been termed adhesive phlebitis under the name of thrombosis, reserving the term 'embolism' for those rarer cases in which the obstructing material is carried into the vein in the course of the circulation.

THROMBOSIS AND EMBOLISM.

1. *Simple thrombosis*.—It is not an unheard-of circumstance for the blood to form a normal coagulum in the veins, without any known cause; but this fact shows, not that the coagulation is truly spontaneous, but only that causes so slight as to be unobserved or forgotten by the patient may arrest the venous current. Pressure and mechanical injury are the most familiar causes of such an arrest, and numerous examples are recorded in which coagula have formed in healthy veins under such circumstances. Thus Mr. Callender² cited from Bouillaud an instance in which the external iliac vein was thus filled with coagulum, when compressed by the intestine distended with feces; another in which the vena cava, and a third in which the internal iliac vein, was closed by the pressure of a tumour; and he related a case under his own observation in which a young man had long lain with his thighs drawn up on the abdomen, and where the mere long-continued flexion of the vessels had obstructed the femoral veins with clot, from the junction of the profunda to Poupert's ligament. He also refers³ to cases of obstruction of veins mentioned by Tweedie as following a contusion of the thigh, and by Lee after a blow on the patella. In the latter class of cases, however, where the coagulation follows on an injury, we must admit that inflammation may have an unknown influence in causing the coagulation, which in the former case seems merely mechanical.

¹ Museum, St. Bartholemew's, series xiii. 156.

² See his essay in vol. iii. p. 360 of the last edition of this work.

³ See his essay 'On Pyæmia,' *ibid.* vol. i. p. 275.

This tendency to coagulate is, as we may easily imagine, much assisted by any cause of weakness, and by many diseases. Thus Mr. Callender's patient, above referred to, was slowly dying of phthisis; and most of the cases we meet with occur in the course of some disease, very commonly pulmonary, or associated with gout or rheumatism. In such cases long tracts of veins have been watched becoming gradually obstructed, without any pain or inconvenience to the patient, and sometimes they as gradually recover.¹ Such, or very similar to such cases of simple thrombosis, are those which occur in the later stages of fevers, where the limbs become œdematous and the veins can be felt to be obstructed in places, yet there is no tendency to gangrene, nor any great cause for anxiety. So again a vein may be simply obstructed by an embolic clot (or by coagulum forming around one), which has been carried into it from a distal part of the circulation. The interposition of the capillaries, and the increasing size of the veins as they pass upwards, render this circumstance exceptional in the systemic veins; but in the pulmonary artery, which is a part of the venous system, it is a well-known cause of death, especially after parturition; and in many diseased conditions, as will be presently shown, the clots found in the veins are essentially embolic, *i.e.* they have passed into the affected vein from an ulcerated or diseased surface. So again in the plugging which so often occurs in varicose veins, it is highly probable that the plug extends to higher parts of the vein, partly by detachment of portions from a plug previously formed below. But, on the whole, embolism certainly plays a less conspicuous part in the obstruction of veins than in that of arteries.

The character, however, of the impacted coagulum is of more importance in the veins; for in arteries the embolic clot is usually a simple mass of fibrine, such as may be detached from a cardiac vegetation, whilst in the veins the clot more frequently comes from a diseased surface, and is unquestionably likely to set up morbid actions in the parts to which it may be carried, leading to general blood-poisoning. These cases form the connecting link or transition between cases of simple thrombosis—mere passive obstruction—and cases of definite phlebitis, in which inflammation plays a leading part, and in which, as will be explained in the sequel, degenerative changes are propagated through the clot to the mass of the blood.

Those pathologists who ascribe nearly all morbid changes to the presence of bacilli find the explanation of the different behaviour of thrombi in the fact of their containing or being free from micro-organisms. The point is one which is now undergoing investigation, and which the experience of future years must solve. At present it will suffice to say that clots formed by healthy blood, such as those due to pressure or contusion, rarely, if ever, lead to any mischief, beyond what is caused by their mere presence; for even the very rare cases where a portion may be detached and carried into the pulmonary artery, so causing death, are only instances of mischief caused by the mere presence of the clot; but that clots which proceed from inflamed surfaces, and especially surfaces which are also putrid or cancerous, are liable not only to set up local suppuration, sometimes of the diffuse variety, but also to poison the mass of the blood and produce septicæmia or pyæmia.

Other circumstances, however, often determine the formation of coagula. 2. Inflammatory changes in the tissues which surround veins. Thus at the base of an extending ulcer the veins are filled with coagula.² As the disease advances, the clotting goes before, and plugs portion after portion of adjacent veins. Rendered solid, they may indeed soften and slough as the disease progresses, but hæmorrhage is, as a rule, prevented by their previous obliteration. 3. Laceration of a vein, as when the placenta is expelled from the uterus. Some blood escapes and coagulates without, and some, but not much, within the vessel, which is itself contracted. Thus, and by subsequent changes, the vein is permanently closed, and coagulation

¹ See Humphry, *On the Coagulation of the Blood in the Venous System during Life*, Case I. Camb. 1859.

² Museum, St. Bartholemew's, series xiii. 61; Middlesex, vi. 52; St. George's, series vi., Nos. 176, 177, 178.

extends from the original seat of obstruction. The following cases illustrate this extension of thrombosis :—

In the body of a man brought to St. Bartholemew's for dissection, death having resulted from phthisis, the nates were covered with sloughing sores. The left femoral, just below Poupart's ligament, was filled with a firm coagulum which ascended to the junction of the epigastric vein. Attention was drawn to numerous veins about the base of the sloughs, which were more than usually conspicuous from being distended with clots. They converged towards and formed the left internal circumflex, and so extended direct to the femoral; and, without doubt, accounted for the clot which had formed there in direct continuity with those in the smaller vessels.

In February 1864 a woman aged twenty died after amputation of the thigh, with symptoms of pyæmia; there was no evidence of vein-obstruction about the vessels of the thigh, but on making a careful examination of the pelvis, which was suggested by the fact that a large bed-sore had formed over the sacrum, a thin plate of fibrine was found at the junction of veins to form the right common iliac. This fibrine partly hindered the flow of blood from the external iliac, but, being broken away from the mouth of the internal iliac, had allowed a quantity of soft clot-débris to pass into the circulation: this débris came from the ischiatic vein, which was filled throughout its entire length by old and softened coagula. The lungs were filled with secondary deposits. In this instance the thrombosis had extended in the veins about the sore on the sacrum, not from that about the amputation wound of the thigh.

The following case is that of a female aged sixteen years, a prisoner in Millbank. On January 20, 1844, she was placed on the sick list. She was of a strumous aspect, and had suffered from attacks of diarrhœa and dysentery, attended with pain about the head, and cramps. The day following the cramps ceased. Pain and tenderness about the epigastric region persisted. The third day she began to complain of pain in the right side of the head, and the right side of the face was slightly swollen. The gums were somewhat affected by mercury she had taken. A glazed red streak extended from a pustule on the right side of the nose to the inner angle of the eye, terminating abruptly. A good deal of the pus had discharged from the pustule during this and the preceding day. The fourth morning she was seized with convulsions of an epileptic character. She became insensible, and on the fifth day she died. The body was examined twelve hours after death. The right cavernous sinus was filled with clots and puriform material, as also was the ophthalmic vein. Elsewhere, each sinus contained dark fluid blood. Two veins, one from the dura mater, the other from the brain, were filled with clots. The vein by the side of the nose also contained coagula. Part of the brain lying over the cavernous sinus was ecchymosed, the blood was coagulated in its vessels, and its tissues softened. From the pustule to the softened brain-tissue the progress of the disease was distinct and not to be mistaken.

Examples to show how veins, after wounds and rupture of their walls, become obstructed with clots, may be taken from those cases of œdema of the legs which so often follow parturition, bad fractures, and even severe contusions.

On July 19, 1855, a woman, aged twenty-four years, was admitted into St. Bartholemew's Hospital, who had enjoyed good health until, about six months before, she had fallen from a height and severely bruised herself about the pelvis. Two months after she was confined at the full time. A few weeks before she had noticed some swelling of her legs, and she subsequently suffered from obscure abdominal pains with occasional hæmorrhage from the vagina. Her emaciation became extreme. The lower extremities became permanently œdematous, and hard cords could be traced along the course of the principal veins. Exhausting diarrhœa baffled treatment, and, sinking gradually, she died about eight months after her confinement. The femoral and all the iliac veins being removed after death, presented the following appearances. In places they were greatly distended, firm and resisting. Between such portions they were contracted and empty. All smaller veins opening into these trunks were occupied by firm, decolorised clots. The tissues around were natural, save about the femoral veins, where they were somewhat thickened. The coagula clung pretty firmly to the walls of the vessels; they showed an arrangement of concentric layers, easily separated one from another. At the contracted points, the walls, as elsewhere, presented a natural appearance. All other parts of the body, excepting the œdematous legs, presented a natural appearance.

Again: a woman, aged sixty-two years, died in the same hospital, forty days after a comminuted fracture from direct violence about the upper and middle part of her right femur. Her death resulted from exhaustion; she sank gradually, with extensive bed-sores. The right lower extremity was slightly œdematous. Great ecchymoses were found about the adductors and the vastus internus. The profunda and its formative branches were plugged as high as the junction with the femoral vein with softening blood-stained clots, of the existence of which there was no suspicion during life. The fractured femur remained ununited. The important relations between these clots and the occurrence of non-union will be subsequently noticed. The predisposition which inclines the blood to form these continuous clots is thus called into activity by accidents of common occurrence.

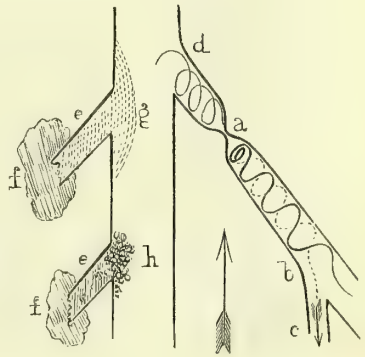
The *coagula extend* in all cases in one of two directions—(*a*) against, (*b*) with the blood-stream. To assist in explaining their extension, the formation of a coagulum in an artery on which a ligature has been tied must be referred to. The process is described in another part of this work (INJURIES OF THE VESSELS). All that is necessary here is to note two facts with reference to the thrombus by which the tube of the artery is finally closed. The first is its formation independent of the division of the middle and internal arterial coats. If a broad ligature is tied round an artery so as to close its canal without lacerating the coats, a clot is readily formed between the ligature and the first branch on the cardiac side.¹ The second fact is that the blood is not stagnant above the ligature, that is to say, in a state of rest, as is usually assumed. On the contrary, it is agitated in an orderly manner, so that the fibrine is, as it were, churned out of the blood to form the coagulum. This may be illustrated by the following experiment. Let an opening (*a*) be made in the side of a common glass test-tube. Between this opening and the closed extremity of the glass let the latter be filled with sand. A stream of water directed through an elastic tube adapted to the orifice (*b*) of the glass will quickly remove the greater part of the sand through the lateral outlet (*a*). What remains will assume a spiral shape, whilst the particles of sand as they are whisked away will indicate a spiral movement of the water-stream, as shown by the plain and dotted lines in the annexed diagram. As the relations are varied between the velocity of the stream, the diameter of the outlet, the diameter of the tube, and the distance between the closed extremity and the lateral opening, so of course will the result be modified. It is in the midst of such an orderly movement, that fibrine is probably separated from the blood above a ligature and forms the spiral and conical clot, which extends to the first lateral branch (where the churning movement ceases), and which, consisting of separated fibrine, is from the first colourless.

FIG. 20.



Under like circumstances, clots form and extend in an obstructed vein (fig. 21, *a*) in opposition to the stream as far as the first branch, as at *b*, where the blood turns back through the collateral vessel (*c*); they also form where the blood regurgitates, as in the subclavian vein from disease of the heart;² but these coagula are produced less rapidly than in arteries, and their fibrine is often largely mingled with other blood-constituents. The blood also finds its way into the vein on the cardiac side of an obstruction (*d*), and supposing vessels (*e e*) to be torn across, what with an external clot (*f f*) and the coagulation within, as at *d*, they are soon plugged to their junction with a larger vessel. The end of the clot in contact with the blood-stream, if in a small vein which opens into one of large size, is round or flattened; if, on the other hand, it occupies the large vessel, its extremity, moulded by the lateral current, is tapering, or otherwise modified in its shape. This may be illustrated by the annexed diagram.³ Beyond any such point the extension of the clot depends, as shown by Virchow, upon deposits from the blood as the latter flows over the coagula, and these additions of fibrine may be arranged in orderly layers (*g*), or may be deposited irregularly, leaving a rough surface as at *h*.⁴ By these accumulations

FIG. 21.



¹ Museum, St. Bartholemew's, series xiii. 141.

² Guy's Hospital Museum, 1521³⁰.

³ See also Museum, Guy's, 1521³²; Middlesex, vi. 52.

⁴ It is from these projecting coagula that fragments and even large masses are separated, pass into the blood-stream, and are carried by it to be eventually lodged in distant organs

the largest veins may be so nearly occluded that a slight additional coagulation at any moment completes their closure. Vessels thus plugged present the appearance shown in fig. 23 (from an obstructed profunda vein), the yellowish or white clot,

FIG. 22.—Diagram of Clot-formation in Veins.



a illustrates the way in which a clot may extend from a branch into a trunk vein by deposition of irregular plates of fibrine on its extremity projecting into the main vein; *b* shows the detachment from that extremity of embolic particles of clot.

having as is usual a spiral shape, and coloured coagula filling its interspaces (often speckled with fragments derived from the fibrine masses), the whole bearing below an impression of the vein-valves.

The changes hitherto described, although as often independent, are frequently associated with ordinary inflammation of parts around the veins, as may be seen in the greater number of the preparations in the London museums. As a consequence of such inflammation (the so-called adhesive phlebitis), small vessels quickly fill with clots; and if a main trunk is then examined, its inner surface will be found dotted over with what at first sight look like plates of lymph, but which are in reality the clots projecting from the branch veins, some firmly attached, some hanging loosely in the canal. From these, as starting points, the main vein becomes in turn obstructed with coagula, more especially if its outer walls are implicated in the inflammation, the clots having often a regular laminated arrangement. At the first large vessel which joins the affected vein the clotting is arrested by the incoming blood-stream; but if, as has been already shown, the disposition to clot-formation is strong, it is only checked at the junction of collateral vessels, and may extend with scarcely any limit either towards or away from the centre of the circulation.

When these clots are removed, the lining membrane of the vein beneath presents a natural appearance; but its outer and middle coats are not unfrequently thickened, and if there be much contraction of the tissues around subsequent to their inflammation, the vein may be thrown into longitudinal folds, or may become tortuous.¹

FIG. 23.



As each coagulum is formed, it contracts; and it often happens, being firmly fixed by its roots, as we may term its prolongations into the small branches, that the vein-wall is drawn with it in its retraction, becoming condensed and thickened in appearance, so much so that when cut across it resembles an artery. Indeed this condition is generally mistaken for an inflammatory thickening of the vessel; but in the case of the young woman narrated at p. 154, suspecting the nature of the change, Mr. Callender removed the internal saphena, which was contracted, thick, and hard, like a piece of whipcord, and having injected water into a part of the vessel, easily restored that portion of the canal to its ordinary size, and the vein-wall to its usual appearance; so that in the preparation² it forms a marked contrast to that part of the vessel which remains condensed. Had its walls been thickened by any inflammatory deposit, they would not have yielded to the slight pressure which was employed. This experiment was repeated on many subsequent occasions.

(fig. 22, *b*). Several cases are recorded in which sudden death has been caused by the lodgment of such a fibrine-mass in the pulmonary arteries; the consequences of their arrest in the arteries of the brain, whither they are usually carried from deposits on diseased valves of the heart, have been fully investigated by Kirkes; and the whole subject of occlusion of the arteries from this cause will be found treated of in the preceding essay. Plate viii. attached to Davis's paper in *Med.-Chir. Trans.* vol. xii., and preparation 1521²² in Guy's Hospital Museum, are excellent illustrations of coagula in a position to be thus washed off by the blood-stream. See also recent observations by Bastian and others, and by Tuckwell in *St. Barth. Hosp. Reports*, vol. v.

¹ Museum, College of Surgeons, 1725.

² Museum, St. Bartholomew's, xiii. 157.

Sometimes the coagulum shrinks to one side, being more tightly held by the branches in that than in the opposite direction, and under favourable circumstances the blood, incessantly endeavouring to insinuate itself into the obliterated vessels, may form a channel by the side of the clot between it and the vein-wall, or in rare instances (referred to by Ribes and others) may drill for itself a passage through the centre of the clot. Under such circumstances the circulation is re-established, though still hindered by portions of fibrine, which form bands and cords stretching across the canal.¹

It more commonly happens that the obliteration is permanent and the vessel is lost to the circulation, the clot (frequently organised) and the vein ultimately forming a firm, shrunken, sometimes calcareous cord. The collateral circulation carries off the blood which should have passed through the lost vessel; though, before this is established, and even after, there is œdema of those parts from whence the return of blood is hindered, and occasionally even hæmorrhage. The extent and severity of this œdema (*white swelling*) will depend (*a*) upon the size of the vein obliterated, (*b*) upon the extent of the obliteration, and (*c*) upon the sufficiency of the anastomosing vessels to remedy the obstruction. When the œdema is attended with considerable pain, a low state of inflammation is superadded. The part is swollen and hard, but does not pit on pressure, as in anasarca, and is not red, as in phlegmonous erysipelas. But these affections are nearly allied, as the one causes cellular inflammation, and erysipelas itself almost always occasions an affection of the veins.

This œdema often embarrasses the repair of fractures, more especially when the fracture occurs near a medullary foramen and involves the laceration of a large vein, or when the tissues around are greatly bruised from the direct violence of the injury, so that clots form in the principal vessels. As this complication is of such common occurrence and of such serious importance, it is strange that attention has been so little directed to it in cases of tardy or non-union. It may be suspected when, about the fourth week after the injury, the parts continue or become œdematous, cold, and often aching. The remedy consists in endeavouring to improve the circulation through the superficial veins, which are least often obstructed, by friction with the hand and by position. It is, however, always a serious affection, as shown by the frequency with which opportunities offer for inspecting the bodies of old and feeble people who die some weeks after a fracture with no trace of union, but with numerous ecchymoses and plugged veins around the seat of injury.²

The degenerative changes which these coagula undergo in the veins are of extreme interest and importance, since the breaking down of the blood-clot may lead to the passage into the proximal end of the vein, and so into the general circulation, of matter which may infect the whole mass of the blood. As stated above, this disintegration rarely if ever takes place when the thrombosis is formed merely of healthy blood-clot: but when the coagulum contains in itself the elements of decomposition³ it softens, and breaks down into a pulpy mass, resembling a mixture of pus and soft clot. The coagula, which are at first of a deep red tint, become brown, or of a rust colour; the red corpuscles diffuse their contents and lose their shape; the clots then soften, and presently become diffuent, so that, after a short time, varying from a few days to a week or more, they form a yellowish fluid resembling pus, or have a sanious appearance from being mingled with colouring matter of a deeper tint. The disintegration commences in the oldest portion of each coagulum, so that it may affect one side, one extremity, or the middle of a clot, as the case may be; it is accompanied by the changes in colour already described, and, from their

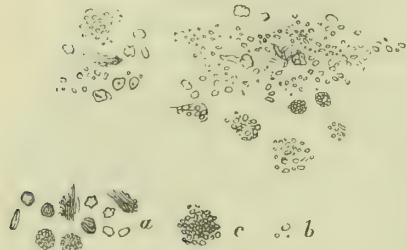
¹ Museum, St. Thomas's, x, 162, 168. With reference to the occasional dilatation of these clots and their connection with the formation of aneurism, see a case reported by Mr. Callender in the *Path. Trans.* vol. ix. p. 93; and *Remarks by Dr. Ogle on the Formation of Aneurism in connection with Thrombosis*, London, 1866.

² See 'Notes on Non-uniting Fractures,' *Med.-Chir. Trans.* vol. li.

³ I leave aside the question whether these elements of decomposition are bacteria or some unhealthy product which, though not depending on the presence of bacteria, may be accompanied by their formation, nay, possibly may cause it.

often acquiring the appearance of ordinary pus, the earlier observers were led to consider these clots as true purulent collections. When examined under the microscope, they are found to contain (fig. 24, *a*) blood-cells variously modified; some mere shreds, others serrated and puckered; some, probably white corpuscles, being pale and transparent when acted on by acetic acid. These are entangled amidst a quantity of granular matter and globules, composed, perhaps entirely, of oil soluble in ether (fig. 24, *b*); here and there many of these granules and globules form masses

FIG. 24.

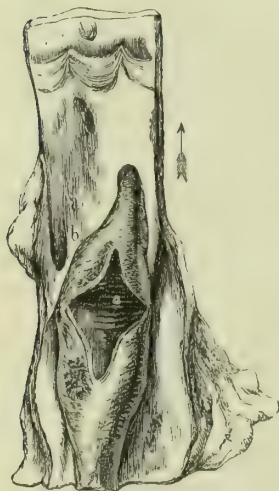


of very variable size, irregular in their outline, though sometimes having a surrounding cell-wall (fig. 24, *c*), which, however, can seldom be demonstrated. These also are soluble in ether. Lastly may be noticed irregular masses of varying size—portions, perhaps, of fibrine as yet unreduced to a granular condition.

The above is Mr. Callender's description of the changes which occur in unhealthy coagula;¹ and he proceeds to deny that in such softening clots true pus is ever found,

although he admits that in suppurative phlebitis, when the walls of the vein soften and give way, pus may pass from the suppurating tissue outside into the cavity of the veins. It is, however, the opinion of many excellent pathologists that clots

FIG. 25.



a, softened clot in the femoral vein, just below the junction of the profunda, *b*. The softened part *a* is shut off from the centre of the vein. The inner coat of the vein was natural. The clot formed after a severe contusion, and the man died four months afterwards of bronchitis. The existence of coagula in the veins had not been suspected during life.

forming in the cavity of uninjured veins may break down into true pus.² The question is one more of microscopic pathology than of practical surgery. No one I think denies that clots formed in the veins may soften and break down into a material either containing or very closely resemble pus; that the presence of such decomposing coagula may cause inflammation and softening of the walls of the vein itself; and that the decomposed material may pass into the mass of the blood and set up pyæmia, as stated in the essay on that subject (see vol. i. p. 180).

The connection between thrombosis and inflammation in or around the wall of the vein is a matter on which much difference of opinion prevails. It is easy to see that the œdema produced by inflammation may so compress the walls of minute veins as to block their current partially or completely, and so cause coagulation in the blocked portion of the vein and in the part behind it, and it seems possible, though it is not proved, that the wall of the vein, participating in the inflammatory changes, may lose its physiological property of maintaining the blood in a fluid condition; and that under these circumstances the blood may adhere to the altered wall of the vessel. Such at least is Billroth's opinion,³ and it is shared by many pathologists.

The clot when softened is usually shut off (sequestered) in an upward and downward direction by newly-added coagula (fig. 25). The softening begins, as a rule, in the coagula last formed, not, as Virchow states, in those first deposited. For in the advance of the malady the patient's health fails and the fibrine becomes more and more prone to disintegrate and soften into a puriform fluid.

The softened clot-débris find its way into the circulation, first, through some

¹ *Essay on Pyæmia*, in the 2nd edition of this work, vol. i. pp. 260, 276.

² Wilks and Moxon, *Path. Anat.* 2nd. ed. pp. 164-6. 'Billroth's Surgery,' *New Syd. Soc. Trans.* vol. ii. 26, 27.

³ *Op. cit.* p. 23.

collateral branch connected with the vein where closed by the softening mass; secondly, by rupture of the clot-wall which separates the débris from the circulating blood (fig. 26), either at its distal extremity, opening into the nearest branch, the clots entangled about the valves preventing their perfect closure, or at its proximal end, the further formation of a clot to confine the débris being usually prevented by the presence of a strong anastomosing blood-current.

The symptoms of obstruction of the deep veins are obscure, even when attended with ordinary inflammation of the parts around. There may be some constitutional disturbance; the superficial veins may be congested, and after a time the occurrence of œdema may be noted. When the limbs are affected, they feel hot and dry, are usually flexed, and cannot be extended without considerable pain. If the superficial veins are involved, they can be felt as hard cords under the finger, the induration being due to the thickening of the tissues around, to the clots within, or, more often, to the two conjointly.¹ The course of the attendant inflammation is marked by redness and tenderness, and may be distinguished from inflammation about the lymphatics by the small size of the cords in the latter, its superficial character, and the rose-coloured redness of the skin. The diagnosis between affections of the deep veins and of the absorbents is not so clear. An accompanying injury, from which the mischief may have started, and which is generally a contusion or an open wound of some kind, will usually suggest to us the probable condition of the neighbouring veins.

In many cases no danger is to be feared; but when large and important veins are extensively affected, as those of the pelvis and lower extremities conjointly, nutrition is so largely hindered that death by no means unfrequently results. The obstructions often cause serious complications, as has been already mentioned, and there is danger of portions being separated from the clots in the veins and causing secondary mischief in the capillaries of various organs (pyæmia).

Sir J. Paget has called attention, in his interesting paper on 'Gouty Phlebitis,'² to the frequency of recurrence and metastasis to other veins, and to the tendency to symmetry manifested by all forms of spontaneous phlebitis, and especially that which is due to, or connected with, the gouty diathesis.³

Such recurrences are, in fact, in some cases most troublesome, the disease no sooner disappearing from one part of the limb or of the body, than it shows itself in another; and often leaving the limb hard, heavy, and very weak. Sir J. Paget also points out that such venous obstruction often leaves behind it a real increase in the size and muscularity of the limb—a true hypertrophy; and that the same result may be produced by varicose veins.

Treatment.—If the nature of this affection is rightly understood, the description of its treatment becomes simple enough. The patient's health must be upheld by doses of bark, or of any other approved tonic; and a generous diet must minister to his amendment. If there be any error, it will be on the side of not doing enough in this respect. Locally, rest must be insisted upon, if possible in such a position as shall favour the circulation through the part affected. The circulation should be promoted in the superficial veins, as has been already indicated, as the surest means

FIG. 26.—Clot from a Pulmonary Artery, its softened contents discharged through its distal extremity. (Museum of St. Bartholomew's Hospital, series xiii.)



¹ Billroth says: 'The diagnosis of venous thrombosis on the ground that the vein feels like a hard cord is not always a safe one, since the inflammatory process in the cellular tissue sometimes takes place, as already stated, exactly (and at first only) around and along the veins, and thus a tube-like thickening of the sheaths of the vessels occurs which may easily be confounded with thrombosis, but by no means necessarily leads to it. This confounding of a periphlebitic induration of the cellular tissue with thrombosis has happened to me twice in connection with the saphena vein, and I look upon it as impossible to form an exact diagnosis in all cases' (*Op. cit.* p. 26).

² *Clin. Lect. and Essays*, p. 292.

³ This form is also well described by Mr. Hewett, *Clin. Trans.* vol. vi. p. xxxvii.

of relieving œdema. If there be pain from an inflammation, it may be soothed by warm fomentations; if it be chronic and from œdema, it is useful to give opium in some form, and thus for the time relieve it. Each case in which the symptoms are at all serious will probably require patient watching; for the disease, with its series of stages, the coagulation, the eventual obliteration and the righting of the circulation, is of slow progress, and must, after all, be left pretty much to nature. Our anxiety to render assistance should never lead us to the employment of such remedies as blisters applied to the œdematous limb; nor can aught but harm be anticipated from depletion, the use of mercury, or of such-like powerful medicine. Except in the case of the complications to which I have referred, a favourable issue may be anticipated.

SUPPURATIVE PHLEBITIS.

It remains to refer to the so-called *suppurative* (diffuse) *phlebitis*. This disease is, in fact, nothing more than a diffused phlegmonous inflammation, and ought to be reclassified with disorders of that character, from which it was separated on account of a prevalent opinion that the inner membrane of veins was the part first and chiefly affected. This inflammation follows the course of veins which, acting as conductors, favour its rapid extension in the direction of least resistance; and hence, as a rule, the disease passes from the small to the larger vessels, since the cellular surroundings of the latter offer the easier route for its advance. That the parts around are first affected, and not the lining of the veins, is shown by the examination of fatal cases. Mr. Callender could meet with no preparation of so-called suppurative phlebitis in which the parts around the veins were not inflamed and thickened.

No patients in a fair condition of health could suffer from this disease. The worst they could be troubled with would be a limited (adhesive) inflammation of the parts around the vessels, with attendant obstruction of the veins with clots. But if the system is depressed and enfeebled, as when suffering from extensive ulcers, from large lacerations, or after severe operations, this disease, attacking wounds and adjacent structures, extends along the course of the vessels (whether veins or lymphatics) just as in other cases it happens to extend along the subcutaneous cellular tissue, and is known as phlegmonous erysipelas. It arises from various local irritations; in one case, the puncture (venesection), in another, the division of a vein, is its starting point; and it often occurs after amputations, as after other wounds; not, however, in consequence of ligatures applied to veins. Whether these vessels be tied or not, this inflammation may supervene; indeed, in every amputation, as remarked by Blandin,¹ the veins which accompany small arteries are always tied; and we have no right to argue that the ligature of a large vein is more likely to be followed by diffused inflammation of its wall, than is that of the smaller vessels. Such an assumption cannot be justified.

Whilst remembering that various degrees of severity exist between the limited (adhesive) inflammation of the tissues around a vein, and the most severe form of diffuse suppuration of the same structures, we will take a bad case of the latter as giving a correct idea of the nature and progress of the disease.

In March 1861 a man died in St. Bartholomew's Hospital under the following circumstances. He fell from a height, and so upon some iron spikes, which penetrated one into either thigh. Diffused inflammation became established along the track of the wounds, more especially on the right. On the fourth day, without material aggravation of the symptoms, the right saphenous vein became indurated along its entire length. The lungs became congested, symptoms of dyspnoea were added, and he died (typhoid) on the seventh day. The right wound extended across the thigh to its inner side, and unhealthy pus was diffused far and wide superficially.

¹ *Journal hebdomadaire*, tome ii. p. 579. Paris, 1829. I dissected, many years ago, the stump of an amputation of the leg, which proved fatal by phlebitis and pyæmia before the ligatures (which were of silk) had separated. Some of the veins had been included in the ligatures, others not. Those which had been tied presented no trace of inflammation. The inflamed veins all commenced by open mouths on the face of the stump.

to the fascia lata. The tissues around the saphena vein were laden with extravasated blood, and with unhealthy sanious pus. The glands, especially about the upper part of the thigh, were enlarged and blood-stained. The outer coat of the saphena was oedematous, the internal surface of the vessel was rough, and the inner coat was, for the most part, wanting. There was no increased vascularity of the vessel. Its canal was filled with sanious pus, and occasional shreds of blood-clots. Just above the inner ankle it was suddenly contracted, and contained a tapering coagulum; and here was the limit of the surrounding inflammation. The femoral vein, at its junction with the saphena, was laden with soft coloured clots, which extended into the external iliac. The lungs were congested and oedematous.

The changes in this and in allied cases may be described as an infiltration of the tissues around each vein with serum and corpuscular lymph. This quickly degenerates, and forms a series of abscesses, or rather a diffused collection of pus. The rapidity with which these results follow each other is most alarming. The veins at first contract, entangling as they do so, some few coagula; but presently such portions dilate. Beyond these, other parts of the same vessel are undergoing, as the surrounding disease advances, the earlier process of contraction; and again, beyond such portions, clots close their canal and mark the momentary limit of the disease. And so it extends, following the course of the vein. All branch vessels are closed with clots, or involved otherwise in the disease, so that no blood flows through the vessel, and thus, and from the condition of the parts around, no nourishment can now reach the inner coat of the vein; so it dies, becoming cloudy, forming an inorganic friable pulp, which gradually melts down until no trace of it remains. The inner coat being destroyed, pus finds its way into the dilated vessels, either direct from the other vein-coats, or through them from the parts around; for these coats, deprived like the inner of their blood-supply, frequently perish in the course of the disease.

The symptoms which accompany these changes are of a low, even typhoid character, ushered in with rigors, and a general increase in the severity of pre-existing signs. If superficial veins are involved, the accompanying induration and congestion of the parts around will mark the progress of the disease; if the deep vessels are implicated, it is upon the accession of general symptoms, and upon the uneasiness about the parts affected, that we must rely for a diagnosis, which indeed is not always easily arrived at. When diffused suppuration is established, a satisfactory issue is doubtful, although in the less severe cases we may succeed in limiting, and so in arresting the disorder.

To effect this, every effort must be directed to the support of the patient with stimulants, nourishing food, and tonics; warm fomentations applied to the parts affected must be combined, if possible, with free incisions to allow of the escape of the unhealthy material depositing along the course of the vessels. But enough has been said in treating of erysipelas and of pyæmia, to render it unnecessary to enter here into details of management, which would be merely a repetition of those recommended for the aforesaid diseases.

In cases of diffused suppuration, the coagula play an unimportant part, very different from that which they occupy in cases of clot-obstruction (more especially when they soften and acquire the puriform condition). Enough has been said to show the great difference between the two affections; but unlike as are the two diseases, they have this in common, that either may be the cause of those secondary complications to which the term pyæmia is properly restricted.

Infants occasionally suffer from inflammation about the umbilical vein, as noticed by Osiander, Meckel, and Duplay.¹ It commences from the second to the twelfth day, and is often preceded by some injury which the child has sustained. In other cases, it would seem to depend upon influences the same as those causing puerperal fever and allied disorders. Duplay found in three out of six cases that erysipelas was associated with the affection of the cord; and occasionally even local gangrene occurs, thus showing the low phlegmonous character of the affection. The

¹ *Revue médicale*, 1838, tome iii. p. 104. See also Morgagni, *Epist. Anat. Med.* liii. art. 37.

general bad condition of the children is also indicated by discharges from the mucous membranes, and by the co-occurrence of purulent ophthalmia. Death occurs from the twelfth to the sixteenth day. The entire cord is involved, thickened, with the structures around, and often with peritonitis. The umbilical vessels are all obliterated in the common affection, their canals being filled with clots, which have been found to extend into the portal veins. The diet of the child and the various secretions require attending to, and warm fomentations may be applied to the inflamed structures; but the tender age of the infant is unequal to resist so serious a disease, for a fatal result has followed in all recorded cases.

Some veins not infrequently contain loose *calculi* or phlebolithes, generally round or oval, and sometimes attached by a narrow pedicle to the inner wall. No inconvenience results from their presence. They are found most frequently in the veins of the pelvis about the bladder and prostate, especially when the latter is enlarged.

Their origin has been much questioned. Bichat¹ thought that they occurred in veins exposed to slow circulation of their contents. Hasse found them connected with varices. Hodgson² held that they were probably formed in surrounding parts, and made their way into the veins by absorption. Cruveilhier stated that they were developed in the centre of a clot of blood. It is, however, most probable that they are clots which have thus dried up and become transformed. Having protruded from some small branch, they receive additions to their surface, and, eventually separating from the pedicle which held them to their original vessel, shift their situation, and are perhaps rolled along for some distance by the blood-stream before being finally arrested.

They are formed of concentric layers, which consist, according to an analysis made by Dr. Frankland for Mr. Callender, of protein matters and phosphate of lime. The former, constituting about twenty per cent. of the calculi, are nearly all albuminous or fibrinous; the latter, though mainly phosphate of lime, is mingled with a little sulphate of potash and sulphate of lime. That is to say, the phlebolithes consist, as might be expected, of the coagulated protein constituents and the less soluble salts of the blood.

HYPERTROPHY AND ATROPHY.

Hypertrophy of veins occurs when any part of the body is the seat of increased growth. It is a natural and healthy change. Thus during pregnancy the uterus is provided with enlarged channels for the removal of its venous blood; and the large veins which form in cases of rapidly growing cancer are often pointed out as a distinctive feature of the disease.

With this form of hypertrophy there is proportionate dilatation, so that the vessels are perfect to perform all their functions. They are thus adapted to new conditions, as when an artery is wounded through a vein, and the latter dilates (aneurismal varix) above and below, its walls becoming thickened so as to resist the arterial impulse.

Hypertrophy with dilatation also compensates for many obstructions to the circulation by fitting one set of veins to make up for the loss of any other. Thus no inconvenience follows when superficial veins are obliterated, for by dilatation of anastomosing branches the circulation is readily re-established. When the vena cava inferior even is permanently closed, it is well known that the lower portion of the vessel dilates in common with the branches opening into it; that various small veins become large—for example, the superficial abdominal or *azygos major*³—and so carry to the heart the blood which ought to have reached the right auricle by the usual channel. Such cases have been long on record. One, described by Halford, is preserved at the College of Surgeons, and shows the iliac vein slightly dilated

¹ *Anat. gén.*, par Béchard, p. 104.

² *Dis. of Arteries*, p. 511.

³ Museum, Guy's Hospital, 1521³².

below an obstructing coagulum, a varicose (dilated) set of veins about the groins having carried on the circulation for several years before death.¹ This kind of dilatation ceases when the veins can conveniently carry the extra quantity of blood, and the change is permanent or temporary as the obstruction remains or is removed, for in the latter case the veins usually regain their ordinary size.

The only anatomical change which attends this increase of a vein is the addition of transverse fibres to its middle coat; its length is unaltered, and its walls remain smooth and uniform, save where pouches behind the valves account for slight irregularities; but as noticed by Baillie and Watson,² 'the vessels are often bent and twisted when the current forces its way backward against the opposing but ineffectual barrier of the valves.'

If the obstruction to the circulation is in the heart, or in the lungs—that is to say, in one of the central organs through which all blood must pass—no roundabout channels can rearrange the circulation. The veins still dilate, but the change is passive, and accommodates them to the blood which accumulates within their canals, because its onward passage is impeded. Thus it happens, with obstruction from disease of one of the valves of the heart, that the entire venous system dilates, so that veins which can be seen, such as the external jugular, are turgid and distended. Maybe, with this dilatation, there is proportionate strengthening of the vein-wall; but it more commonly happens that the yielding is simply passive, increasing until relieved by rupture of the wall (hæmorrhage) or by exudation of serum (anasarca).

Atrophy of veins, in common with atrophy of other structures, naturally follows disuse of a part. After amputation above the knee, the femoral vein lessens to one-third of its previous size; after removal of a testicle, the corresponding spermatic veins shrink and waste. In a case in which the right kidney had been transformed into a large cyst from the impaction of a calculus in its ureter, the canal of the renal vein would not admit an ordinary-sized probe.

Degeneration of the coats of a vein is never associated with atrophy of the vessel; indeed, its rarity under any circumstances offers a marked contrast to its frequent occurrence in arteries. In the Museum of St. George's Hospital,³ a vein from the broad ligament of the uterus contains a round white mass within its tunics, the vein being pervious; in another case,⁴ a calcareous deposit involves the internal saphena; and Baillie mentions a case where a similar deposit was found in the coats of the vena cava inferior, near its division into the common iliacs. Bécларd observed calcareous degeneration in the femoral vein, and Macartney and Andral in the internal saphena. It has also been met with in the hepatic veins;⁵ but its occurrence may be considered accidental wherever situated. Indeed it is doubtful if these calcareous plates should be regarded as a degeneration of the vein-wall; it is more probable that they depend upon an after-change in some local deposit of fibrine.

VARICOSE VEINS.

Varicose veins. Varix. Phlebectasis.—When a vein becomes dilated without any good object or purpose, it is said to be varicose. In the active or passive dilatations already described, which adapt these vessels to certain states of the circulation, the purpose is as evident as is the gain which results. Not so with varices. No good comes from them. They are useless and hurtful.

Many of the early medical writers were familiar with much that is at present known respecting varix. It is still the 'dilatation of a vein' described by Paulus

¹ Museum, 1732. See cases by Morgagni, Portal, Petit, Cline, and others; also Reynaud, in the *Journal hebdomadaire*, tome ii. Paris, 1829.

² Museum, Middlesex Hospital, series vi. 32c. *Trans. of a Society for the Improvement of Med. and Chir. Knowledge*, vol. i. p. 127.

³ Series vi. 191.

⁴ Museum, St. Thomas's Hospital, x, 170.

⁵ Museum, College of Surgeons, 1438.

Ægineta ;¹ and our treatment of the dilated vessel continues practically unchanged. Some veins, so far as is known, are unaffected by varices, while among those which have been reckoned as varicose a considerable number ought rather to be referred to that hypertrophy with dilatation which has been already described.

True *varices* are commonly met with in the submucous veins of the bladder and rectum (hæmorrhoids),² in the spermatic veins (varicocele, cirsocele),³ and in the veins of the lower extremities. They are also, though rarely, met with in the veins about the face ; more especially those of the lips and eyelids. In one specimen they may be seen involving the internal jugular ;⁴ in another the veins of the stomach ;⁵ and they are said to affect the pharynx, œsophagus, and small intestine, but of these the records are unsatisfactory. One case of varix at the bend of the elbow is recorded by Petit ; and a boy is stated by Warren to have suffered from varix which formed between the shoulder and elbow after violent muscular exertion ;⁶ but phlebectasis of the upper extremities is a very rare occurrence.⁷

Varices of the *lower extremities*, though much had been written respecting them, received but little attention from anatomists. This neglect occasioned and maintained the error of Boyer, adopted by most of those who wrote upon the subject, that varices are an unnatural permanent dilatation of the *subcutaneous* veins, from which the *deep* veins are at first exempt, and that the latter, constantly sustained by the muscles, receive from these contractile organs a support by which they escape dilatation, whilst the subcutaneous, less well supported, can expand indefinitely.⁸ The disease, limited in its origin to one set of vessels, was said to be caused by a retrograde movement of the blood, or by a mechanical obstacle to the return of the blood to the heart, or by a communication between the arteries and veins, small vessels passing directly from the one to the other. The last suggestion, however attractive in theory, failed from the absence of anatomical proof, for the presence of the anastomosing vessels has never been shown by dissection.⁹

The error of Boyer's doctrine rested upon insufficient anatomical research ; for in fact varices do not invariably commence in the trunk of the saphena, or in that of any superficial vein. The seat of varices, as shown by Verneuil,¹⁰ is as often in the deep veins, and they thence extend to the subcutaneous vessels by the numerous anastomoses existing between the two sets ; and, far from being rare, the deep varices are of very frequent occurrence.

There are various veins in the thickness of a limb ; some deeply seated in company with the great arteries, the popliteal, posterior tibial, and the like ; some which lie in the subcutaneous tissue ; and, lastly, intramuscular veins, which convey blood from the muscles to the deep or superficial vessels, and form anastomoses between them. These intramuscular veins carry large quantities of blood, and their capacity is great in proportion. Mr. Callender proved anatomically that the six principal veins which pass in the adult male from the soleus muscle to the peroneal and posterior tibial vessels, have a united diameter of not less than an inch. Where these vessels open into the deep veins (more especially the peroneal and posterior tibial) the latter are often greatly dilated, as may be seen by fig. 27, which indicates their condition in a case of varix examined in a body brought to St. Bartholomew's for dissection. Broca, quoted by Verneuil, found deep varices equally with the sub-

¹ 'Varix venæ dilatatio est, aliquando in temporibus, aliquando in una ventris parte, sub umbilico, nonnunquam etiam circa testiculos, sed maxime in cruribus.' — *Opus de Re Medicâ*, Lat. don. p. 50. Paris, 1532.

² See DISEASES OF THE RECTUM. ³ See DISEASES OF THE MALE ORGANS OF GENERATION.

⁴ Museum, St. Thomas's Hospital, Y, 155.

⁵ Museum, College of Surgeons, 1158.

⁶ *Traité des Maladies chir.* tome ii. p. 49 ; *Surgical Observ. on Tumours*, p. 432.

⁷ An interesting preparation in the Museum of St. George's Hospital, series vi. 242, shows all the deep veins of the arm varicose. The clusters of veins surrounding the main artery received an obscure pulsation from it, and there was much difficulty in determining the nature of the affection. It was noticed to come on after striking a violent blow.

⁸ Boyer, *Traité des Maladies chir.* tome ii. p. 451 ; Sir Everard Home, *Practical Observations*.

⁹ Pigeaux, *Traité pratique des Maladies des Vaisseaux*. Paris, 1843.

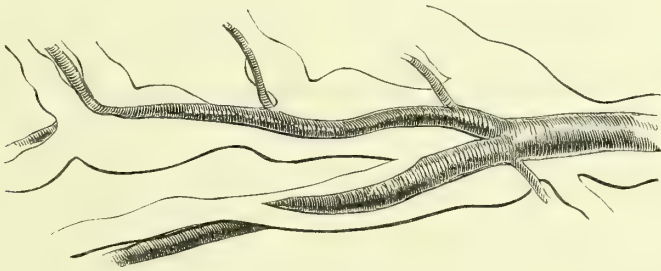
¹⁰ *Gazette médicale*, 1855. *Gazette hebdomadaire*, 1861, p. 428.

cutaneous; Denucé observed that they were less rare than had been supposed, and existed even when the subcutaneous veins were unaffected; Deville and Fouché, their attention being called to the subject, confirm his statements; and Dumay communicates a case in which, whilst tying the peroneal artery, it was found to be surrounded by large varicose veins with extremely thin walls.

According to Verneuil, the intramuscular veins also become varicose, and specimens are preserved in the Musée Dupuytren¹ to show they are sometimes affected without change in the subcutaneous. Mr. Callender failed to meet with this intramuscular varix;² but from the examination of bodies brought for dissection he was able to confirm the statement of Briquet, that at the spot where varices are most common, large trunks communicate through the muscles with the deep veins; and the latter were found as commonly diseased as the superficial vessels, the disease being most advanced where the intramuscular veins empty their blood into either set.

Causes.—Certain conditions of system favour the formation of varices, congenital predisposition amongst others; a disposition thought by some to be hereditary. Very little is known about it. Persons with an indolent temperament, or persons reduced in health,³ suffer from a relaxed and debilitated condition of the vein-walls, which lose their tone and their elasticity, and then offer little resistance to the pressure of the blood. In some cases, the heart's action is reduced in frequency (I have seen young adults in whom it beat but forty times in the minute) and in force, so that it

FIG. 27.



slowly and with difficulty relieves itself of the venous blood. Such people, and others to a less extent, are more likely to suffer from varix if their occupation is one which habitually involves much standing or walking—in fact, any long-continued muscular exertion; and so cooks and grenadiers have been selected by Brodie and by Home as especially prone to the formation of varicose veins. They are developed chiefly during the active middle period of life; but their appearance may be postponed until old age, or may be referred to early life, since they not unfrequently occur in children under ten years of age.

Obstruction to the circulation is a passive aid to their formation. Hence they coincide with certain diseases of the heart, of the lungs, with cirrhotic liver, and are common when the portal system is overcharged with blood, as with those who *live well*, though such suffer more especially from varices of the rectum (hæmorrhoids). Constipation, involving the accumulation of fæces in the intestine and pressure upon the iliac veins, the obstruction of veins with clots, the pressure of tumours, and such artificial pressure as that of an ill-adapted hernia truss or tight garters, may be enumerated as examples of conditions which retard the circulation, distend the veins, and prepare them to become varicose.

Such conditions have more influence upon the veins of the leg, because the pressure of the column of blood which these vessels have to resist is increased by

¹ Specimens, 254, 259.

² The various opinions on this and other points in the anatomy of varix are fully discussed in chap. i. of Mr. Gay's work *On Varicose Disease*. London, 1868.

³ On the influence of gout, see Paget, *St. Bartholomew's Hospital Reports*, vol. ii.

gravitation. Although the column of venous blood, ascending against its own weight, is supported by the column of arterial blood, yet the pressure of the fluid upon the walls of the veins increases by gravitation, inch by inch, towards the most dependent portions of the body. To illustrate this fact, the small intestine, freed from its mesentery, may be held so that its upper and lower outlets are upon the same level, the intermediate curve being pendent. If its canal is filled with water, it is easy to compare the lax condition of its walls above with their tension, almost to bursting, at the curve below. In the veins this tension is relieved by valves, and some dilatation is permitted, as occasion requires, by their thin and yielding walls; but when the occasion passes by, the elastic vessels soon recover their natural capacity, and then the slightest force acting upon the blood-column tends to quicken its movement through the venous system. If there exist a tendency to dilatation by obstruction, such force, instead of moving the blood-column, is expended upon the vein-walls; ¹ and if the force is represented by a certain quantity of blood forced into a vein, then there is added an increased tendency to dilatation by excess of contents.

In persons with relaxed and debilitated veins the varicose condition would seem to be determined by the habitual *over-exercise of muscles*, especially those of the calf of the leg, which force the blood violently into vessels inclined to yield to the distension, and already over-filled by reason of a retarded or obstructed circulation. The dilatation which ensues is usually of slow progress; indeed, for a time the veins are often increased in thickness and strength to resist this distension; but Paré records cases, and his observations are confirmed, in which large varices have suddenly appeared after violent muscular exertion,² such as running, dancing, or carrying heavy weights. Wherever, so far as superficial varices are concerned, the intramuscular veins pass into the subcutaneous, there the varix is first noticed; there the force, that is the blood-stream impelled from the muscles, tends to act on the vein-wall and to dilate the vessel; for the valves obstruct below, and the column of obstructed slow-moving blood resists above.³

The *anatomical changes* in varicose veins have been described by Andral; and his distinctions, though too minute, have been generally adopted.⁴ In brief, it is sufficient to notice that the coats of the dilated vessels may become thickened, or may become thin; that they may be lengthened, so that the veins are rendered tortuous; that the dilatation may be unequal, the vein being marked with pouches, which form at the sinus behind each valve, or result from the greater yielding of the vessel where the blood is forced into it from an intramuscular branch; that varix of the femoral vein, which occasionally requires to be distinguished from a femoral hernia (see HERNIA), is thus formed by yielding of the vessel at its junction with the internal circumflex, saphena, and profunda veins.

As the canal of the vein dilates, the valves, unless previously ruptured by violent and sudden muscular action, are unequal to close the passage; and, being useless, they presently waste and are reduced to mere fibrous bands, or disappear altogether.⁵

¹ See experiments by Williams, *Principles of Medicine*, 2nd ed. p. 188.

² Warren, *op. cit.* See also Malgaigne, *Œuvres compl.* tome ii. p. 268.

³ Mr. Gay has elaborately considered the question of the cause of varicosity (see *op. cit.*) So far as I can judge, it seems desirable to assign as causes those mentioned in the text, especially the influence exercised by the intramuscular veins upon the deep and subcutaneous systems of veins in the lower extremities.

⁴ Varices: species 1. Simple dilatation, affecting the whole length of a vein, or existing only at intervals. 2. Simple dilatation, with thinning of the parietes. 3. Uniform dilatation, with thickening of the parietes. 4. Dilatation at intervals, with thickening at the dilated points; in this, and in the third species, the vessel being lengthened as well as dilated. 5. Dilatation, with the formation of septa, which divide the interior of the varix into many compartments, in which the blood coagulates. 6. The addition to the last of many small apertures in the walls, allowing the escape of blood, as in erectile tumours.—*Pathological Anatomy*, Eng. Trans. vol. ii. p. 4 *et seq.* Dublin, 1831.

⁵ Museums, Coll. of Surgeons, 1736, and Bartholomew's Hospital, series xiii. 79. Gay is of opinion, 'As a rule, veins that become varicose are destitute of valves; and the cords which have been supposed to testify to their existence in these veins are referable to another source, viz. blood-clot.'—*Op. cit.* p. 105.

The valves are not destroyed by the backward pressure of the column of blood obstructed in its passage to the heart; for they are adapted, as is well known, to resist this pressure, and they become, when needful, thick and strong, to fit them for doing so. But the force represented by the stream of blood advancing from below, and from the intramuscular veins, presses upon their rear, and, as they are unable to resist a force acting in this direction, flattens their cusps against the vein-wall; and there, when the vein, from the combined action of several causes, has become so large that the valve-cusps are unable to meet and close its canal, they shrink and atrophy. It follows that, in varices, those valves only are thus destroyed which lie between the lowest varix and the heart; and, when they are destroyed, that the pressure of the blood-column, which they helped to resist, weighs more heavily upon the dependent and dilated vessels.

The tissues which surround the diseased veins become gradually absorbed in consequence of the continued pressure of the varix, and thus, as noticed by Hodgson,¹ bones even become indented. So thin, indeed, may the coverings of a varix become, that, with sudden exertion, or from a blow, they rupture, and hæmorrhage ensues. In cases of long standing, however, it is usual to find the neighbouring structures thickened and hard from simple œdema, or from inflammatory exudation, which, by involving the neighbouring lymphatics, causes many of them to be permanently obstructed; so that, what with their obstruction and the obstructed vein-circulation, the whole leg becomes œdematous, and in time accumulates a great superfluity of fibro-cellular tissue, a condition which in severe cases is recognised as the Arabian elephantiasis.²

Symptoms.—Though varices may exist for a long time, and cause little, if any, inconvenience, yet it is more usual for those who suffer from them to complain, some time before the external manifestation of the disease, of aching pain, deep seated in the limbs, with sense of weight, fulness, and fatigue, in some cases complicated with a certain numbness and even loss of power in the extremities. In a more advanced stage of the disease, the ankles swell after a hard day's work, and the feet are constantly cold. These symptoms indicate an embarrassed state of the circulation, to which is gradually added dilatation of the deep-seated veins, and more especially of the posterior tibial.

After a time, at one or more points in the leg, a small tumour, in an early stage resembling the 'venosité' of Briquet, is formed, soft, of a bluish colour, from the dark blood showing through the integument; it disappears on pressure, but returns when the pressure is removed, or when the patient stands up, and is caused by a vein which is dilating where joined by an intramuscular branch. Around this tumour a series of minute vessels are clustered of a dark, bluish colour—the small superficial veins through which the passage of the blood is retarded to a greater degree than elsewhere, because they open directly into that part of the vessel which is dilating. By degrees the dilatation extends and involves an increasing length of vein, and then forms irregular, knotty, convoluted tumours, soft and diminished in size by the horizontal posture, giving a bluish tint to the skin, which is stretched and thin, and surrounded by smaller veins, also somewhat varicose. These tumours are grouped around the points at which the dilatation first commenced, for the most part in the middle of the leg along the track of the external and internal saphena veins, but the clusters of tortuous vessels often extend along the entire length of the leg and thigh. To the symptoms already enumerated there is often added an unpleasant itching; and when nerve-fibrils are by chance involved, a sharp tingling pain.

Occasionally, when the varices gradually thin the skin which covers them, and burst through it, hæmorrhage ensues, which may cause syncope, and even death, if not promptly arrested; for the valves being destroyed between the varix and the heart, the escape of blood is directly from the proximal portion of the vessel, and may be very considerable. In treating such a bleeding, the patient should be

¹ *Op. cit.* p. 561.

² For erectile tumours, and their relations to varices, see NÆVI.

promptly laid on the ground, and the leg should be raised, when the hæmorrhage will probably cease. If it continue, the pressure of a pad of lint applied to the bleeding vessel, and secured by a few turns of a bandage, will effectually arrest it.

In inflammation of the tissues around the veins we have the prelude to irritable conditions of the skin and eczema, to obstruction of the absorbents, and to ulceration;¹ and when the vein-walls from the same cause become surrounded with lymph, the condition is reached in which, as previously described, the vessels become filled with clots and obstructed. The knotty tumours are then hard and cannot be emptied by pressure, and this consolidation is permanent, for varicose veins once obstructed with clots never have their canals reopened. In this way the natural cure of a varicose cluster is often effected, with much temporary relief to the patient: as, however, the predisposition continues, and the exciting cause remains, other adjacent veins soon become involved, and perpetuate the disease.²

Treatment.—Varices of long standing are inveterate; for, although much may be done for their relief, they cannot be cured; and hence it is fortunate, although they occasion the patient much hurt and inconvenience, that they are not serious in their consequences. In their earlier stages they are more manageable; and it is much to be regretted that early symptoms are mostly unheeded, for whilst the disease is limited to the deep veins, or at most has involved but slightly the superficial vessels, it admits very readily of permanent benefit.

The management of the general health is an important item in the treatment of varices in every stage. The feeble and often ill-nourished patients who suffer from this disease must be invigorated by tonics and a generous diet. The plethoric patient, with an embarrassed portal circulation, will gain much from often-repeated but small doses of purgative medicine, and the use of cold saline baths. In each case some special symptoms will probably demand attention, and must be met by appropriate remedies; but in the large class of cases in which there exists a constitutional or acquired laxity of the veins, no remedy equals the tincture of the perchloride of iron, with an aperient pill every other night to obviate the occurrence of constipation. Under its influence, combined with proper local appliances, the laxity of the veins disappears, and the varices, if recent, are disposed of.

Provided always that the disease is not of long standing, and that local causes of obstruction, such as tight garters, are done away with, it is advisable, with this general treatment, that the legs should be rested in the horizontal position for at least a month or six weeks. Walking should be prohibited, and only carriage exercise allowed. The limbs, thus rested, should be bandaged from the toes to above the knee, the pressure being firm and equal, and the bandage (Domett) should be renewed daily. At the time of each renewal the limb should be well rubbed with the hand for about a quarter of an hour; by this treatment the circulation through the subcutaneous veins is rendered brisk, and the tonicity of the walls by degrees re-established. What with the inaction of the muscles, the improved tone of the superficial vessels, and the amendment of the general health, a good result may be anticipated.

But patients seldom have the inclination or the opportunity for submitting to such rigid treatment for the cure of a disease which causes comparatively little inconvenience; and when this is the case simple compression of the distended veins will often give great relief, and even prevent the disease from growing worse. Sufficient support may be obtained by merely bandaging the limb, greater pressure being made over the larger of the varicose clusters than elsewhere by means of a pad of lint placed upon each of them before the bandage is applied.³ Elastic spiral bandages, or the elastic web stockings, are recommended as conveniently supplying the necessary support. They should be removed at night when the patient goes to bed, and replaced when he gets up in the morning. If any one of them causes irritation of

¹ For varicose ulcers, see vol. i. p. 148. ² See cases by Hodgson, *op. cit.* p. 561.

³ Local compression was first recommended by Delpech and Sanson. See Delpech, *Maladies chir.* tome iii.

the skin, it must be changed for some other ; and it will often be found useful to protect the integument by means of flannel bandage or cotton-wool before these appliances are put on. The most difficult to manage are the old varices surrounded by a quantity of indurated tissue, which protects them from ordinary pressure, but the difficulty may generally be overcome by the exercise of a little ingenuity in applying the supports. Travers cured a varicose cyst of the saphena by the pressure of strips of plaster. The varix should be emptied of its blood, and the strips, of a convenient length and breadth, should be then applied, crossing one another at right angles. A firm and even pressure may also be obtained by applying a wet bandage. A number of pieces of muslin, linen, or calico are prepared, each about two inches wide and twelve inches long, and saturated with water. Two of these strips are first placed beneath the foot, and their ends crossed over the instep towards the ankle. Other strips are then bound round the leg, their ends crossing in front, so arranged that the one above half-covers the one below, until the limb has been bandaged to a sufficient height. An ordinary roller is then placed over all, and each day the application is renewed.

These measures are, however, simply palliative ; and in the desire to effect the cure of so common, and often troublesome, a disease, many devices have from time to time been employed. With the exception of Herapath's suggestion for dividing the fascia lata at the saphenous opening to relieve a supposed pressure upon the femoral vein, they all aim at procuring obliteration of the varix, or of the chief vein connected with it. The so-called 'radical' cure of varicose veins is in very many cases really only temporary or palliative. Even though the cluster of veins operated on be cured, yet when the patient returns to active life others form in the neighbourhood. Still, the temporary inactivity, and the cure of the chief varix, may suffice for the healing of an obstinate ulcer, or may restore congested and irritable skin to a healthy condition, and is pretty sure to alleviate pain. For these reasons only it may be worth the patient's while to undergo an operation involving little pain or danger. Again, when the main varices are cured, the patient, if provided with a suitable bandage, is very much in the condition of one in whom the disease is incipient ; and who, as above said, with proper care and attention, rarely suffers any material inconvenience or after ill-consequence. But there is no question that the cure of varices by obliteration of the veins is sometimes complete and permanent, particularly when the varicosity affects only a limited portion of the vessels. I saw the other day a patient on whom Mr. H. Lee had operated about ten years previously ; and in whom no unnatural enlargement of the veins was anywhere perceptible.

Numerous operations are in use for the obliteration of varicose veins. They seek either merely to produce coagulation in the varix, or also to divide the venous channels above and below the varices, or finally to remove the varicose part of the vein. These results can be attained—1st, by the action of caustics applied over the course of the vessel ; 2nd, by subcutaneous division of its walls ; 3rd, by compressing it between a steel pin and a twisted suture, or by some similar contrivance, and, lastly, by complete excision. The potassa fusa, or Vienna paste,¹ may be applied, as recommended by Mayo, in quantity sufficient to cause sloughing of the skin over a varix, or the venous trunk connected with it. The tissues beneath the slough inflame, the vessel is filled with coagula, and so becomes obliterated. The slough should not exceed a quarter of an inch in its diameter, and the surrounding skin should be protected from the action of the caustic by a ring of plaster encircling the portion to be destroyed. Brodie recommends that sufficient caustic shall be employed to insure sloughing of the vein, as a more certain mode of securing its destruction, the vessel becoming closed and contracted above and below the slough. According to circumstances, two or more of these sloughs will be required, and in making them they must be carefully kept some distance asunder. Whether the varix is thus itself destroyed, or the venous track which passes from it, the blood which formerly

¹ Composed of five parts of quicklime and four of caustic potash, made into a paste with spirits of wine immediately before its application. Nitric acid may be substituted when it is only required to excite inflammation about the vein.

passed through these vessels is driven into other channels, which gradually dilate into a fresh crop of varices.

Subcutaneous division of varicose veins is easily performed by means of a narrow pointed bistoury, first employed by Brodie,¹ which is introduced between the skin and the vein, and is made to divide the latter as it is withdrawn. A compress of lint should be at once applied to restrain hæmorrhage. This operation has the advantage of leaving a wound which heals readily, often by the first intention; but in some cases suppuration has followed, and in some it has failed to obliterate the vessel; so that, says Brodie, 'it really appears it is not worth patients' while to submit to it. I have always observed, that if I cured one cluster, two smaller ones appeared, one on each side; and that ultimately I left the patient no better than I found him.' If this operation is performed to facilitate the healing of a varicose ulcer, the vessel should be divided, if possible, below, so as to interrupt the blood as it streams in from anastomosing vessels and causes the distension of the veins about the ulcer. After this, or any similar operation, the patient must be kept quiet in bed for at least four or five days, and longer if necessary.

Velpeau, following Davat, employed a metal pin, which he passed under (never through²) the vein, and on which he applied a twisted suture. The pin was allowed to remain in until sufficient inflammation had been excited to promote obliteration of the vein; but when the irritation which followed was but slight, the pin was left to come away by ulceration of the structures which covered it. Some of these pins he applied to the varicose clusters, and some to the veins communicating with them; and as no very bad results followed his operation, it was pretty generally tested. But, like others, it affords only temporary relief; and, besides, is open to the objection that the sores which result are often difficult to heal, although this is an objection more especially to the treatment by caustics. To prevent sloughing of the integument, it is recommended by some surgeons to protect it from the twisted thread by means of a piece of wax bougie. Various other devices for conveniently securing the obliteration have from time to time been suggested.³ A good and expeditious plan is that recommended by H. Lee, by whom it is thus described: 'A needle is introduced beneath the vein or veins to be obliterated, and an 8-ligature is passed over its extremities. The vein or cluster of veins is thus included between the needle, which is below it, and the ligature, which is over the skin. The ligature is then tied so as to produce a slight degree of pressure on the vein, and by this means its cavity is temporarily closed by acupressure. Another needle is then passed under the vein at about an inch distance, and the vessel is there closed in like manner. The vein or cluster of veins thus included between the two needles is entirely separated from the rest of the circulating system, and may then be divided or otherwise obliterated without risk. Subcutaneous section of the vein is generally all that is necessary, and is preferable to any other mode of operating, as it effectually obliterates the vessels without leaving any open wound. At the expiration of about four days, when union is established in the divided parts, the needles are removed, having served their temporary purpose.'

Finally, there is the complete excision of the varicose portion of the vein, introduced into practice by Mr. Marshall.⁴ This operation 'consists in excising a considerable length of the vein where it is most enlarged, and is performed as follows: The course of the vein having been marked with ink, a pin is passed under it at each end of the part to be removed; the limb is now emptied of blood by Esmarch's bandage, the skin is divided along the marked line, and the vein, previously secured by figure-of-8 ligatures passed over the pins, cut across at each end and dissected out; the wound is then dressed after Lister's method.' It is evident that there can be few cases of

¹ *Lectures on Pathology and Surgery*, p. 185.

² Transfixing the vein and passing a thread through it, as proposed by Fricke, was found to occasion such great irritation that its use was presently abandoned.

³ Metal pins for compressing veins are described in the *Medical Times and Gazette*, vol. ii. 1861, p. 377.

⁴ *Lancet*, Jan. 23, 1875.

varicose veins to which so very severe a proceeding can be justifiably applied; but where the varix is very limited yet troublesome, excision is appropriate, and I have seen cases in which it has been successfully practised. And it is still more appropriate in cases of perfectly circumscribed varix such as are sometimes met with where there is a limited tumour, more or less filled with clot—a sort of venous aneurism. I have seen two such cases operated on: in one case by mistake for a melanotic growth, in the other under a correct diagnosis, and in both with perfect success.

Except in cases which have been referred to, these operations are not to be recommended; and the patient, if wise, will be content with the palliative measures of a more simple character.

Reference has several times been made to tumours as causing obstruction to the circulation of the blood through veins. Little inconvenience follows, in consequence of the ready formation of a collateral circulation. Some tumours compress veins against a resisting substance, as bone; some by their growth completely surround them; whilst others extend into their canals, as was first pointed out by Langstaff in a case of medullary cancer. In many instances they cause obliteration of the vessel by interruption of its canal and by absorption of its coats, or they induce the formation of clots, by which it becomes permanently obstructed. Now and then a tumour appears to have its origin in and to be confined to a vein, as happened in the splenic, as recorded by Hodgson, and in a case, related by Andral,¹ where the growth consisted of adipose tissue in the wall of a portal vein.²

A few words will dispose of the subject of worms and other parasites which were formerly supposed to infest veins. The more exact and minute examinations of the present day have refused in this matter to confirm many of the statements of the past. Parasitic animals, except in the cases of migration of the embryo of *tænia*, and in the instances quoted below, are rarely found in these vessels.³

G. W. CALLENDER, 1870.

TIMOTHY HOLMES, 1882.

¹ *Op. cit.* vol. ii. p. 423.

² The following specimens give a good general idea of these vein obliterations. Middlesex, series vi. 32, 35: vena cava obliterated by pressure from an aneurism. St. Thomas's, x, 171; vein filled with encephaloid deposit. Guy's 1521⁶⁵: vena cava obliterated by the side of a dried-up hepatic abscess; and 1521⁹⁰, by pressure from enlarged glands. Guys, 1522⁷ 15²⁵: growths of cancer into superior venæ cavæ. St. Bartholomew's, 13, 29; fleshy growth between vena cava and kidney, obliterating the former. Aneurisms and abscesses, though they sometimes burst into adjacent veins, may also cause obliteration: St. Bartholomew's, 13, 84; St. Thomas's, x, 154; St. George's, vi. 128.

³ Andral, Duval, Treutler, Fabricius, Rudolphi, Virchow, and Leuckart may be referred to. I find mentioned by one or other of these, *echinococcus altricipariens* and *distoma hepaticum* in the hepatic veins; *acephalocysts* in the pulmonary veins; *strongylus* and *filaria* in the veins of a horse; and *entozoa* belonging to the class *nematoidea* of Rudolphi in the right ventricle of a porpoise. *Hæmatozoa*, as they are termed, are said to be found in the veins of birds, reptiles, and fish, having perforated the vessels, as it is assumed, in their wanderings, and being then washed along the blood-stream until they stick in the capillaries. Leuckart, quoted by Küchenmeister (*Syd. Trans.* vol. i. p. 50), professes to have met on four occasions with the embryo of *tænia* migrating through the main branches of the vena porta. (See also Siebold, *Syd. Soc. Trans.* p. 29.)

The remarkable discoveries of Bilharz, Griesinger, Lautner, and others respecting the presence of small flukes (*Bilharzia hæmatobia*, Cobbold) should be referred to. They have been found in the portal system and in the veins of the mesentery and bladder. It is stated that in 363 autopsies 'Griesinger found this entozoon present no less than 117 times.' In advanced cases of the disease, as it occurs in Egypt and at the Cape of Good Hope, severe diarrhœa and hæmaturia precede death. Dr. Cobbold is so good as to inform me that he has discovered the same parasite in the portal blood of the *Cercopithecus fuliginosus*. The reader is referred for further details to Dr. J. Harley's paper in *Med.-Chir. Trans.* vol. xlvii.; or to Dr. Cobbold's treatise on *Entozoa*, p. 197 *et seq.*

DISEASES OF THE URINARY ORGANS.

UNDER the term *urinary organs* will be here comprised the kidneys, ureter, bladder, prostate, and urethra.

It is extremely desirable, when dealing with any disease the symptoms of which are referred chiefly or entirely to some limited portion of the important system defined above as urinary organs, to possess an intelligent acquaintance, not merely with any part which may be especially liable to suffer morbid changes, but with the system itself as a whole. It is absolutely necessary to the formation of a correct diagnosis to be familiar with the intimate relations which exist between each portion of that system, as well as with the various peculiarities which each is prone to exhibit when influenced by disease. Few things conduce more to error in estimating symptoms than a too exclusive specialism in the observation of disease. The study of stricture and of other forms of urethral obstruction, of vesical diseases, of calculous formations, and of those chronic changes in the secreting structure of the kidney which are conventionally assigned to the province of the physician, must be pursued together if the surgeon is properly to appreciate the import of any one of these affections. The relations which mutually subsist between each of the series, not only by contiguity, but by other and less obvious connections, are so numerous and constant, that a study of the whole can alone qualify the practitioner intelligently to treat disordered function in any part thereof. No man can deal adequately and safely with cases of impaired urinary function whose hand is not well trained to the use of the sound or catheter, whose eye is not familiar with urinary deposits in all their varieties, and who is not acquainted with their indications, and with the subjective phenomena which accompany them. The exploring sound is quite as essential to the diagnosis of urinary disease as the stethoscope is to affections of the chest. He who is, conventionally speaking, a physician only, will (and does) constantly overlook calculus and stricture, to the great detriment of the patient; while the mere surgical handiworkman will (and does) treat mechanically many a case which can only be injured by his manipulations. With these views, the careful study of all acute and chronic renal affections is recommended to the student who desires to qualify himself specially for the practice of surgery. The limit assigned to urinary diseases in this work forbids more than the slightest glance at them; it appears, therefore, the more necessary to make these introductory remarks.

THE KIDNEYS:

Malformations.

Injuries (Vol. I. Essay on 'INJURIES OF ABDOMEN').

<i>Inflammation</i> (nephritis)	{	traumatic, idiopathic, and by extension.
" <i>acute</i>		calculous.
		from obstruction in the passage below.

<i>Inflammation</i> (nephritis)	{	calculous.
<i>chronic</i>		from obstruction.
		diathetic.

<i>Inflammation of pelvis of kidney</i>	{	from obstruction.
(pyelitis) <i>acute and chronic</i>		calculous.
		scrofulous.

Calculous nephralgia. (See also 'Renal Calculus,' vol. ii. p. 178.)

Abscess of kidney and fistula.

Perinephritic abscess.

Tumours of kidney.

Suppression of urine.

Hæmaturia.

Malformations.—The following are the ordinary varieties. (1) There may be only one kidney, which is then usually larger than natural; it may lie in its usual place, or may consist of the two organs joined in the median line, and occupy a position in front of the vertebral column. (2) One kidney may occupy its ordinary situation, and a second may be movable, forming a tumour recognisable during life; or it may be fixed in an unusual situation, lower than natural, or within the pelvis. (3) The kidney may present an outline more or less lobulated, showing the persistence of a form existing in foetal life, and natural in some of the lower animals.

Nephritis.—Acute and chronic.

Acute nephritis, of a severe form, is common in surgical practice. It exists also as a sequel to pre-existing chronic inflammation of the kidney, and in Bright's disease. The causes of the first-named variety, with which we have to deal here, are as follows:—

Wounds, bruises, and strains; by extension from the bladder in cases of calculus, stricture, and cystitis, following operations or otherwise; retention of urine, causing distension of the ureter and pressure on the kidney; renal calculus; entozoa; extension of inflammation from neighbouring parts, as diseased vertebræ, &c.; diuretics in over doses; cantharides and turpentine; exposure to cold; and alcoholic drinks. Most of these causes act almost exclusively on the male, and in connection with surgical affections. In the female, nephritis is more commonly associated with uterine diseases.

Symptoms.—The first is usually an attack of rigors; nausea, often vomiting, prone to be obstinate, generally soon succeed. Pains in the back and loins, increased by the upright position, by coughing and vomiting, even by respiration, and often extending along the ureter. Occasionally aching or numbness in the thigh of the side affected, and tenderness in the renal region. Micturition frequent; the urine mostly high-coloured and scanty; neutral or alkaline; often mingled with blood, and then becoming albuminous, not otherwise; later it may be purulent. Under the microscope renal casts may be found containing pus and blood-corpuscles. Sometimes total suppression occurs. General signs of fever are present, sometimes severely. Anasarca often appears, in cases suddenly occurring from exposure to cold; not commonly in cases of extension from the bladder. In these, suppuration in the substance of the kidney is to be dreaded; the symptoms are then more intense, there is great depression of the vital powers, and fatal coma often occurs by uræmic poisoning.

As it is impossible to include in this work a history of all the renal and allied affections with which the surgeon should be familiar, a few remarks on the differential diagnosis of nephritis will illustrate the leading characters of other diseases which might be confounded with it.

The *diagnosis* is generally not difficult, although in a few instances it is obscure. If a patient, who has suffered long from urethral or vesical disease, or who has recently undergone an operation for stone or stricture, is suddenly attacked with fever, vomiting, pain and tenderness in the renal region, scanty or bloody urine, there can be little doubt of the presence of acute nephritis. When there is no history of previous urinary complaints, acute nephritis may sometimes be confounded with the following: calculous nephralgia; pyelitis, simple and calculous; perinephritis; perinephritic abscess; spinal disease, or abscess of the psoas or adjacent parts; lumbago; renal neuralgia and hysteria; inflammation of the bladder; vesical calculus.

1. *Calculous nephralgia*; by which is intended the pain and systemic disturbance occasioned by the descent of a calculus from the kidney to the bladder, and which

sometimes resembles very closely acute nephritis. Indeed, excepting only the severe febrile symptoms, all those of nephritis are present: acute pain, especially on one side, shooting along the loins to the sacrum, with retracted testicle; but the invasion is more sudden, and the pain more acute, than in nephritis. There may be vomiting, frequent micturition, and bloody urine; but the constitutional disturbance falls short of the fever which accompanies the inflammatory affection. If the calculus obstructs the pelvis or ureter for any length of time, symptoms of calculous pyelitis may arise. And lastly, all the phenomena may suddenly disappear, confirming the diagnosis of calculus, especially if signs of its presence in the bladder supervene.

2. *Acute calculous pyelitis* may be distinguished by the following characters: the pain in the back is excessively severe and lancinating, more so than in nephritis; shooting pains are felt in the groin and inner part of the thigh, radiating to the testicle, which is generally strongly retracted. When pyelitis is unaccompanied by renal affection, the urine is often acid; and although scanty at first, is subsequently voided in natural quantity. It may have much pus and epithelium mixed with it, sometimes blood; if so, these matters are found in intimate admixture with the urine. The course of the complaint is less rapid than that of nephritis, and there are frequently considerable intervals of freedom from pain. It may be followed by chronic calculous pyelitis; evidenced by persisting pain, although varying in degree, at one spot in either loin; tenderness on pressure there; aggravation of symptoms by movement, and appearance of increased inflammatory products and of blood in the urine from same cause.

3. *Perinephritis; caries of spine*.—Inflammation of the tissue surrounding the kidney does not generally make its appearance with an acute attack. The subsequent formation of matter, if it takes place, is accompanied by febrile symptoms; but the gradually increasing swelling, in its later stages presenting fluctuation, while at the same time the urine is healthy, is significant of simple perinephritic abscess, provided the special signs of spinal disease are absent. If, on the contrary, there has been marked tenderness on pressure or percussion at one spot over the vertebral column, or *à fortiori*, angular curvature; if the functions of sensation or of motion are affected, the spine is obviously the seat of disease. When abscess of the psoas exists independently of spinal disease, there is generally some disturbance in the nerve-function of the corresponding thigh; and the motions of the hip-joint will be impaired.

4. *Rheumatism* of the dorsal muscles, or lumbago, produces great pain on making movement of these muscles, much more so than in nephritis; and vomiting and other constitutional signs are absent. Again, the urine is neither suppressed nor materially altered in character; it may be unusually acid, but not alkaline.

5. *Renal neuralgia* is met with, but chiefly in women. Very severe pains are complained of by individuals of nervous and hysterical temperaments obviously not due to nephritis. The pale and abundant urine, the absence of constitutional symptoms, and the existence of mental excitement, suffice to mark these cases.

6. *Acute cystitis* sometimes produces symptoms which seem to indicate that the kidney is the seat of disease. There may be great pain in the renal region, as well as in the pubic and perineal regions, with febrile symptoms; but there are suprapubic tenderness and pain in passing water, while the urine, usually acid, exhibits abundance of exudation-matter, and is clouded, yet has only traces of albumen and no blood mixed with it. It may contain pus, and be alkaline; but this is generally as the acute subsides into the chronic form of disease. In later stages of severe cystitis the urine becomes bloody.

7. *Calculus of the bladder* can rarely be mistaken for acute nephritis. Still there may be present temporary irritation of the kidney, arising from the presence of calculus in the bladder. The previous history and symptoms will indicate the real cause, and the sound subsequently employed at the proper time will clear up any doubts if any still exist.

Treatment of acute nephritis.—It is necessary at the outset to insure free action of the liver and bowels, which are often very obstinate. Perfect rest in bed, and

low diet, are to be enjoined. Local bleeding by leeches or by cupping may relieve. The utility of antimony and salines (generally more or less diuretic) is questionable, and the repeated administration of diuretics is contra-indicated; the moderate use of simple diluents, water, linseed-tea, barley-water, or milk-and-water, is preferable. Free action of the skin should be promoted by hot or air baths or large hot fomentations. For the vomiting, when obstinate and distressing, counter-irritation to the loins and pit of the stomach affords better results than medicines; a constant supply of ice in the mouth also helps to allay it. When head-symptoms appear, the most efficient remedies are purgation and renewed counter-irritation over the renal region; also similar applications to the temples and nape of the neck, with hot bottles and sinapisms to the feet and legs; but cantharides should not be employed, on account of its known irritant action on the kidney; the object may be attained equally well by chloroform, ammonia, or mustard. In later stages of the complaint, internal stimuli and support may be necessary.

Where acute nephritis first shows itself, as is often the case in surgical practice, by extension from the urethra or bladder in a debilitated subject, these general principles must guide the treatment. All unnecessary irritation of the urinary apparatus must be avoided, and no catheters be passed, unless absolutely necessary, and then with the utmost care and gentleness. If suppuration take place in the kidney, or the urine be suppressed, little can be hoped for from treatment; active counter-irritation of the renal region and internal stimuli must be perseveringly employed while any hope exists.

Treatment of the attack of calculous nephralgia.—The hot bath; antispasmodics and opium liberally administered; and hot cataplasms to the renal region; mild diuretics, particularly the decoction of triticum repens; abundance of diluent drinks. Sometimes inhalation of chloroform is of service.

Treatment of chronic pyelitis.—If occurring from obstruction in the urethra, the most efficient treatment is that which enables the urine to pass freely, and relieve the dilated pelvis of the kidney from pressure. Purulent discharge is sometimes diminished by buchu, or by cubebs and the balsams; sometimes by mineral acids. If the complaint depends on calculus in the kidney, and the nature of the formation is indicated, appropriate remedies can be taken with the view of hindering its increase. Such are alkaline salts, as potash and lithia in uric acid calculi, and acids, mineral or benzoic, for those which are phosphatic. Wherever the signs of general malassimilation are present, especially those of the tuberculous diathesis, appropriate treatment must be enjoined. Scrofulous pyelitis is, however, rare.

Abscesses may be formed under these circumstances; also as the sequel of nephritis; they should not be opened until the tumour points and the diagnosis is perfectly clear. Often they are perinephritic, although originated by disease within the kidney itself; occasionally a calculus may be removed through the opening made. Or, nephrotomy may be performed for the purpose in some cases (see p. 179).

Other tumours in the renal region may be confounded with abscess, such as cystic disease of the kidney; simple fluid distension of the pelvis; accumulation of blood there; encephaloid and tubercular deposits, and hydatid cysts; besides abscesses from spinal caries. Among these, ordinary cystic disease affords no very obvious signs: the character of the urine may be unaffected; if the cyst is large, dulness on percussion is present. Distension of the pelvis with fluid may be due to retained urine, or merely serous fluid, and may in very rare cases afford the sense of fluctuation externally. If there is a partial communication with the ureter, the amount of water passed will differ greatly on different days. Cancer of the kidney is encephaloid in six cases out of seven; the pain is severe, the growth rapid, the tumour extremely large and abdominal; hæmaturia is present, and the diathesis is generally marked. Tubercle in the kidney rarely produces a tumour appreciable during life, and its symptoms point more to the bladder than to the organ affected: tubercle in the lungs, and elsewhere, usually coexist. Tumours containing blood are almost invariably recognised as originating from direct violence, or from a strain in violent exercise. Tumours containing acephalocysts are very rare; they are usually in con-

nection with the pelvis of the kidney, and may exist for a very long period without rupture, subsequent to which hooklets, &c. are found in the urine. In rare instances, both these and the tumour produced by great distension of the pelvis of the kidney have been successfully punctured. But the entire organ has been successfully removed in several instances for tumour and other grave conditions (see 'Nephrectomy,' p. 180).

Chronic nephritis is not always a well-marked disease, except as a sequel of the acute attack, not including under the term that constitutional state of which the most marked sign is the admixture of albumen in the urine, and which is ordinarily known as Bright's disease. Here the kidney is, strictly speaking, perhaps secondarily affected; but the fact of its degeneration may be always noted in advanced stages. It is of the utmost importance that the surgeon should be familiar with its phenomena, as, in dealing with diseases affecting the bladder or urethra, the presence of Bright's disease is a circumstance of grave import, which may greatly influence the treatment; nevertheless, its purely medical character as a blood disease must exclude its consideration here.

The remedial means for simple chronic nephritis consist in local stimulating applications to the renal region, avoiding specific renal irritants, before specified, combined with the constitutional treatment of chronic inflammation.

Renal calculi.—(See the essay on CALCULUS.)

Hæmaturia signifies simply the presence in the urine of blood; which may exist in any quantity, from an amount discoverable only by the microscope, up to that in which it constitutes the major proportion of the fluid passed by the urethra. It is a symptom merely of disease in some part of the urinary organs. When blood is present in small proportion, and has been in contact with the urine for a considerable time the latter presents a peculiar brownish colour, characteristic to the practised eye, and commonly known as the 'smoky tint.' If in large quantity, under similar circumstances, the mixture may be deep red or like muddy coffee. The source of the blood in hæmaturia may be the kidney, the pelvis of the kidney, the ureter, bladder, prostate, or urethra.

Hæmaturia occurs in acute and chronic diseases of the kidney; from injury, as by blows, strains, &c.; from calculus in any part of the urinary tract; from violent diuretics, as turpentine or cantharides; in cystitis sometimes; in prostatic disease; in malignant disease of any part of the urinary organs; in villous tumours of the bladder; in the hæmorrhagic diathesis; and in certain states of the blood, as in fever, purpura, and allied conditions; in stricture of the urethra; from chordee; from the local application of mechanical and chemical agents.

It is always important to determine its source. The following hints will assist in forming a correct diagnosis:—

Renal hæmorrhage, not being traumatic, is usually preceded or accompanied by some signs of kidney-disease; most frequently acute desquamative nephritis, and renal casts are usually present; the blood is intimately mixed with the urine, which has the smoky tint. Further, as a rule, when such urine is passed without pain, or other local symptom, the blood is probably derived from the kidney. Hæmaturia from a calculus impacted in the pelvis or ureter is associated with the history of the occurrence (see 'Calculous Nephralgia'). Hæmaturia caused by a blow on the back is mostly from the pelvis or ureter. Malignant disease occasioning hæmaturia presents sooner or later some physical characters associated with the organ affected.

Blood derived from the neck of the bladder or prostate generally remains within the cavity, and if in large quantity forms a clot there, distending the viscus; or the urine has the colour of porter, and a darker sanies comes away at the close of micturition. In malignant disease of the bladder or prostate, shreds of tissue come away with the urine, and occasionally cancer-cells (so called), and the blood is apt to appear suddenly in large quantity. In villous tumour, characteristic shreds are sometimes detached; in both this and the preceding case the bleeding is large, and its occurrence

irregular, but it is less so in the latter case than in the former. With villous growth the blood is more intimately mixed with the urine, which is constantly more or less stained. The appearance of a drop or two of almost unmixed blood at the end of passing water may be caused by either calculus or chronic prostatitis; the history, the distinctive symptoms, and the sound will determine which.

When the hæmaturia is due to urethral sources (such as injury to the penis from blows, lacerations or falls, with or without pelvic fracture; chordee; rupture in sexual intercourse; from surgical instruments; from severe efforts to pass water in stricture; impacted calculus; in severe gonorrhœa; phagædenic ulceration; and malignant disease), it will be found that, although blood is often mingled with the urine, it often issues from the urethra in a pure state, and independently of micturition.

It is necessary to be certain that the dark colour is due to blood. Bile, rhubarb, and other colouring matters, also mere concentration, produce a dark and reddish tinge. The disappearance of the colour by heat, and the precipitate of albumen, indicate blood; but the microscope determines it without fail.

Treatment.—Renal hæmorrhage must be treated, when due to calculus, malignant disease, and violence, by absolute rest, in the recumbent position, and by internal styptics, such as alum, gallic and sulphuric acids, matico, and acetate of lead, combined with opium; when produced by purpura and Bright's disease, by iron and other appropriate remedies. Hæmorrhage of the bladder may demand similar general management, if it is considerable; but local means are here more powerful. Thus ice may be applied to the perinæum and hypogastrium; or, better, a little ice-cold water, or iced infusion of matico, be injected into the rectum, or small pieces of ice placed in the bowel. It is recommended that efforts to remove a clot should be made by a catheter and syringe; but such interference is undesirable, unless absolutely necessary from retention of urine. The breaking up a clot is liable to open vessels closed by recent fibrin, and to provide a fresh cavity into which more blood may be poured. Besides, there is no ground for regarding the clot as a great evil, which must be got rid of at all hazards. The solvent power of the urine is very great, and is probably the safest agent in effecting the purpose.

It might possibly be necessary to remove firmly adhering coagula, and the bladder has even been opened above the pubes for that purpose; but I have found it better to let nature do the work than to be officious in rendering assistance. The patient's distress is greatly relieved by opium; but when he cannot pass any urine by his own efforts, a full-sized catheter should be passed, and a lithotrity aspirator adapted to it, by means of which the clot may be gently withdrawn.

Suppression of urine.—This term denotes failure of the kidney to perform its function of secreting urine. The bladder is empty, or, having been emptied, continues so, since it receives no more by the ureters. Meantime the materials of the excretion accumulate in the blood, and the vital powers become oppressed; a comatose state ensues, and finally death, unless the eliminating function of the kidney is resumed, and the urine again excreted. This function is sometimes totally, but only temporarily, suspended; more commonly it is after long impairment by chronic disease gradually extinguished. Advanced chronic disease existing, any sudden shock from operation, however slight, from acute attack, &c., may rapidly induce fatal suppression. The two conditions of suppression and retention have been much confounded. None, however, can be more distinct: in the former the bladder is empty, in the latter it is unnaturally full; in the former no urine is secreted, in the latter the secretion goes on as usual, but some obstacle opposes its removal from the bladder.

Treatment.—Local cupping; but if the patient is in low condition, without abstraction of blood; hot fomentations and counter-irritation to the renal region. The hot-air bath and free purgation, to aid in eliminating excreta from the system. I have seen, in one case only, recovery after forty-eight hours of complete suppression: I have seen it not unfrequently after twenty hours. In the latest stage of chronic renal disease, little is to be hoped for from treatment.

Malformations of the ureters.—The most common deviation is that of increase in number; two or three ureters may issue from one kidney, and may be continued

down to the bladder, more frequently uniting to form one channel. Sometimes one ureter only exists; sometimes it is incomplete, and forms a canal with a closed extremity. The ureter is liable to inflammation, which extends by it from the bladder to the kidney. It may be the subject either of stricture or of obliteration, which conditions are generally produced by injury caused by the passage or impaction of calculi; occasionally from pressure by a tumour; rarely from external injury. It is often greatly dilated, when obstruction exists at the neck of the bladder, or in the urethra, sometimes to such an extent as to become a supplementary reservoir to the bladder. A calculus is sometimes arrested in its passage through the ureter, occasioning great agony (see 'Calculus Nephralgia').

RENAL CALCULUS AND OPERATIONS FOR ITS REMOVAL, &c. NEPHROTOMY;
NEPHRO-LITHOTOMY; NEPHRECTOMY.

The kidneys frequently become the seat of calculus formation, in the form of abundant crystalline deposit natural to the urine ('sand'), and by the aggregation of this into masses ('gravel'). The size of these when first formed is usually small, and their form more or less spheroidal, so that they pass down the ureter without difficulty into the bladder, although often not without causing severe pain. Many, however, pass without the patient's knowledge, and his first acquaintance with the fact of their presence is obtained by observing them in the urine he has passed. The composition of these bodies, which vary in size from that of the smallest shot to that of a kidney-bean, is, for the most part, either uric acid, alone or with a base, or the oxalate of lime; the latter occurring in a small proportion of cases, when compared with the prevalence of the former. More rare still is the formation within the kidney of a phosphatic calculus, although common in the bladder. (For a complete history and description of these, see article 'Calculi,' p. 235. And for the symptoms which mark the transit of a calculus from the kidney to the bladder, and the treatment appropriate, see 'Calculus Nephralgia,' p. 175.) In a few instances, the calculus fails to leave its seat in the pelvis of the kidney, and increases by accretion there, until it is too large to descend by the ureter, a condition of serious gravity for the patient. For a calculus retained and augmenting in size in the kidney is not only the source of almost constant pain, often causing nausea and impaired digestion, but an active life becomes difficult or even impossible, from the aggravation of suffering excited by movements of all kinds. The calculus by its presence materially injures the renal structure, as may be learned by the hæmaturia which often occurs after exercise. Notwithstanding all that has been attempted in this stage by medical treatment, little has been accomplished, and the patient finds relief almost solely in inactivity, and in the use of opiates. The effort to remove a calculus from the renal region has never until quite recently been attempted, except when fistulæ have been present, through which, by means of a probe, the foreign body could be felt. And occasionally openings have been made in the renal region to evacuate obvious collections of pus, in some of which the calculus has escaped. But the experience of the last ten years, although not yet large, certainly warrants the attempt to explore, to open, and even to remove a kidney, in some conditions, and in the presence of certain symptoms. Mr. Thomas Smith of Bartholomew's, in a paper read before the Royal Med. and Chir. Soc. of London in 1869,¹ was perhaps the first to indicate that nephrotomy might be desirable in other cases than those for which incisions had heretofore been reserved, such as the examples referred to above. Since that time the experience of Simon of Heidelberg and of Czerny; Martin of Berlin, Brandt in Austria, Peters of New York, Smith of New Orleans; Durham, Annandale, Bryant, Arthur Barker,² Morant Baker,³ and

¹ *Trans.* vol. lii. April 1869.

² *Trans. Med.-Chir. Soc.* 1880 and 1881; vols. lxiii. and lxiv. Two papers relating to nephrectomy by lumbar and abdominal section, with careful analysis of numerous cases.

³ *Report on 'Diseases of the Kidney, which require Surgical Operation,'* at the International Medical Congress, London, 1881.

Morris,¹ among others here, have established the claim, on behalf of several forms of procedure, to rank as recognised surgical operations of value and of the first importance. Such operations may now be regarded as naturally falling under three heads; and, apparently, almost by general consent, the three following terms are accepted as expressing their nature and design in each instance:—

1. *Nephrotomy*: comprehending incisions down to and, if desirable, into the kidney-structure, for purposes not necessarily associated with calculous symptoms.

2. *Nephro-lithotomy*: designating incisions expressly intended not only to expose a portion of the kidney, but to remove a stone therefrom.

3. *Nephrectomy*: the most formidable of the three, indicating a procedure by which the whole of the kidney is removed.

The pathological conditions which have given rise to these operations have been numerous and varied. The symptoms which have indicated a resort to the knife have of course been severe; pain, generally of long standing, localised in one spot; augmented by exercise, associated with the appearance of blood in the urine, together with a more or less impaired condition of the general health. In many cases tumour has been present; hydronephrosis, cystic, malignant, or scrofulous kidney. Movable painful kidney has also been several times extirpated. All these, besides the presence of calculus, the subject now under consideration, have been treated by one or other of the operations referred to. And there remain still a few instances in which severe pain referred to the situation of the kidney, but of which no clear explanation was attainable, have been treated by an exploratory nephrotomy without finding any mechanical or structural cause, yet followed by great relief to the patient.

In cases with marked and long-continued symptoms of renal calculus, the operation of nephrotomy must certainly be regarded as likely to offer the most effectual remedy. At the same time, these are by no means to be regarded as the best adapted for operation. Experience is beginning to indicate that in early, but well-marked and painful cases, a most favourable issue may be hoped for; while for cases which are far advanced, and in which the calculus may be large and branched, the dangers and difficulties of operation may be extreme. Conducted with due care, a simple nephro-lithotomy, although serious, is not to be ranked as a dangerous operation. The preliminary employment of an acupuncture needle, where the seat of pain is distinct and unvarying, sometimes serves to establish the diagnosis by detecting the calculus, and may be useful again at a later stage of the incisions.

Operations of nephrotomy, and of nephro-lithotomy.—In either case the line of incision is the same: the removal of the stone demanding division of renal structure, depending on the size and situation of the calculus. When this is very large, and especially if it be branched, it may be desirable to perform nephrectomy, rather than to make an attempt to break up and detach piecemeal a large and rough formation, a procedure liable to produce very free bleeding from laceration of renal tissue.

The first incision much resembles that employed in lumbar colotomy, but may with advantage commence higher, and end at a lower point than in that operation; hence the line gradually descends instead of following a transverse direction. It should commence at three to four inches from the spines of the vertebræ near to the last rib, and should gradually tend downwards for about four or five inches in the space between the rib and crest of the ilium, dividing first the skin, then the fascia and superficial muscles (*latissimus dorsi* and *transversalis*) to the same extent; the edge of the *quadratus* is found and drawn backwards to the middle line, when deep fasciæ and fat come into view and are dissected, avoiding or pushing away in the anterior angle of the wound the peritonæum, which may be encountered partially overlapping the colon there. At the middle and upper region of the wound the perirenal fat is seen; this is separated and divided carefully, and the kidney itself sought beneath; its

¹ Case of nephro-lithotomy, *Clin. Trans.* vol. xiv. 1881. Some important cases have since occurred, by Mr. M. Beck, Mr. H. Butlin, Dr. Whipple, and Mr. J. W. Haward. For particulars see 'Report of Clinical Society of London,' in *Lancet*, Feb. 4, 1882.

exploration by finger follows, and by needle if necessary. If the calculus is felt, the renal tissue is divided upon it by the knife, or, as the organ is very vascular, by cautery (Paquelin's cautery knife : Barker), and the calculus removed.

Experience, however, is teaching that, although on first incising the renal substance the hæmorrhage which instantly follows is very severe, and almost indeed alarming, it speedily stops with pressure. A slight puncture by the bistoury may be made, to begin with, and this may be dilated by dressing forceps, as a means of limiting incision.

Nephrectomy.—The incisions are the same. If more space is required, and the first incision has been carried rather in a transverse than in an oblique direction, a vertical incision may be made to fall from above into the transverse incision near its inner end. But a well-planned oblique incision will mostly render this unnecessary. In order to obtain additional space for removing a large mass of kidney or tumour, the last rib has been resected; in one case the eleventh rib was thus removed in error, which resulted in opening the pleura, with collapse of the lung, and death. But on reaching the kidney, the tumour presenting may often be much diminished in size by puncture. In such cases, and also when the calculus is large and branched, the entire kidney should be removed at once, the separation of such a calculus being difficult, and liable to occasion dangerous hæmorrhage. The surface of the kidney being found, it is not difficult to enucleate the organ if the inner surface of the capsule is carefully followed with the finger. Any attempt to dissect outside a thickened capsule, and remove it also, will be attended with difficulty, danger, and probably with severe bleeding. Having enucleated all round as far as to the hilus, a stout silk ligature is to be carried round or through the pedicle, by means of a stout, blunt-pointed, curved needle in a long handle, and a firm knot made, to include all the structures (duct, vessels, &c.) in one or in two portions. The mass is then divided near the ligature and removed, stitches inserted towards each end of the incision, and a drainage-tube left in the wound.

The kidney may be removed also by incision into the cavity of the abdomen, a course more likely to be selected in the presence of considerable tumour, relative to the exact relations of which some doubt may exist. Judging from the not very extensive data, this appears, as might be expected, to be a somewhat more hazardous proceeding than the lumbar operation, in which the peritoneal cavity should not be opened.¹ If the abdominal cavity is selected as the route, the operation should no doubt be made under strictly antiseptic conditions. In view of the possibility of opening the peritonæum by the lumbar route, it has been usual to employ the same conditions also, at any rate until after the safety of the peritonæum has been assured.

The question of risk incurred by removing a single kidney, from a physiological point of view, has now been satisfactorily investigated, and it is generally conceded that a remaining healthy kidney may be safely trusted to perform the necessary renal function.

THE BLADDER.

Malformations.—1. Absence of bladder. The organ is sometimes, although rarely, absent. (*a*) The ureters may communicate directly with the urethra; an abnormality which has been only observed in the male sex. (*b*) Less rarely the ureters enter the rectum, and discharge the urine there. (*c*) A few instances are on record in which the ureters opened directly into the vagina.

2. Two or more bladders may co-exist in the same subject as a congenital malformation, but this is exceedingly rare. Sometimes the organ appears to be partially divided by a septum, or to be formed of two more or less symmetrical lobes; but although these cases have been regarded as malformations, they are in reality the effects of disease.

3. Extroversion of the bladder. In these cases, which are not rare, the anterior

¹ From Mr. Barker's paper, before referred to, it appears that the kidney has been removed by the lumbar section twenty-seven times, with eleven deaths; and by the abdominal section sixteen times, with eight deaths.

wall of the bladder is wanting, while sometimes the pubic symphysis is about also. The posterior wall and base of the organ are pushed forward by the abdominal viscera, and form a red flattened prominence, covered by mucous membrane, in the situation of the pubes. The orifices of the ureters may be seen just below the centre, beneath the lower margin a short imperfect penis projects, and at its root a rudimentary prostatic structure exists, with more or less hernia of the bowels on either side in a pouch of integument, which represents the scrotum, and contains the testes. The mucous membrane is sensitive, readily bleeds, and from the projecting orifices of the ureters urine is continually discharged, excoriating the skin and producing a continual urinous odour. The malformation thus described affects both sexes, but is more common in the male.

Treatment.—The results of extroversion may be palliated by well-adapted mechanical means; but many surgeons have attempted by operative measures to remedy these defects. Dieffenbach and Langenbeck in Germany, Richard and Nélaton in Paris, Pancoast of Philadelphia, Mr. Simon of St. Thomas's Hospital, and Dr. Daniel Ayres of Brooklyn, U.S., have done so with varying success. More recently, Mr. Holmes of St. George's has succeeded in covering the part by lateral flaps, in a young male child.

Since this case he has improved his method, and repeated the operation several times. By covering in the exposed mucous surface and leaving a small opening only at the lower part for the escape of urine, the pain of contact is saved between the surface and the clothes, and the urine issues without excoriating the skin.¹

Mr. John Wood, of King's College Hospital, has also practically studied the subject of plastic operations for this deformity, and with considerable success.²

Injuries of the bladder.—(See Vol. I. 'Injuries of Pelvis.')

Diseases of the bladder.—I shall adopt the following classification for the sake of perspicuity; studying first those diseases which present local anatomical characters, establishing the nature of the lesion giving rise to the symptoms observed; and, secondly, those more obscure diseases in which similar symptoms occur, but are not accompanied by obvious structural changes.

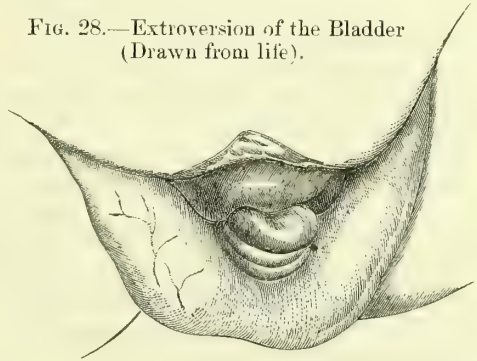
I. Diseases which involve recognisable organic structural changes.

Inflammation (cystitis):	Acute . . .	{ due to injuries and operations.
		„ presence of foreign bodies (calculi, &c.)
		„ prolonged retention of urine.
		„ extension from urethra or kidney, or supervening on chronic cystitis.
		„ external cold.
		„ chemical irritants taken by the mouth.
		„ chemical irritants injected into the bladder.

¹ *The Surgical Treatment of Children's Diseases* (London, 1863), pp. 146–149.

² *Med. and Chir. Trans.* for 1869, vol. lii. pp. 85–131.

FIG. 28.—Extroversion of the Bladder
(Drawn from life).



The upper and largest prominence is the mucous membrane of the bladder, with an aspect like red velvet; the mouths of the ureters are hidden beneath its lower margin. Below that is the short and wide penis; the exposed urethra opened out in its whole course on the upper aspect. The large pendulous bag below all contains the testicles and some intestine.

Inflammation (cystitis):	Chronic (a with, and b without, catarrh):	{	as a sequel of acute.						
			as the result of obstruction to the outflow of urine, from						
			<table> <tr> <td>stricture of urethra.</td> </tr> <tr> <td>tumours in urethra.</td> </tr> <tr> <td>bar at neck of bladder.</td> </tr> <tr> <td>enlarged prostate.</td> </tr> <tr> <td>calculi in the urethra.</td> </tr> <tr> <td>tumours of the penis.</td> </tr> </table>	stricture of urethra.	tumours in urethra.	bar at neck of bladder.	enlarged prostate.	calculi in the urethra.	tumours of the penis.
			stricture of urethra.						
			tumours in urethra.						
			bar at neck of bladder.						
			enlarged prostate.						
			calculi in the urethra.						
			tumours of the penis.						
			from foreign bodies in the bladder.						
„ growths in the bladder.									
„ altered urine.									
„ paralysis.									
„ over-distension or atony.									
„ displacement.									
„ disease of neighbouring organs (uterus, rectum, &c.)									

Suppuration of the bladder.

Abscess of the bladder.

Ulceration, simple and non-malignant, and gangrene.

Vesico-intestinal fistula.

Hypertrophy and sacculation of the bladder: dilatation.

Vesical hæmaturia. (See 'Hæmaturia.')

Tumours and growths	{	1. Fibrous	{ warty.
			{ polypoid.
		2. Villous or vascular.	
		3. Epithelioma.	
		4. Malignant.	

Tubercle of the bladder.

Bar at the neck of the bladder.

Hernia of the bladder.

Foreign bodies in the bladder.

Calculi. (See the essay on that subject.)

Inversion of the bladder.

Rupture of the bladder. (See the section on 'Stricture.')

II. Conditions which do not necessarily involve obvious organic structural change.

Paralysis.

Atony from over-distension, caused by	{	organic obstruction to outlet.
		retention of urine, voluntary or involuntary, no
		organic obstruction being present.

'Irritable bladder' (i.e. act of micturition abnormally frequent).

'Spasm of the bladder' (i.e. contractions of the bladder involuntary, and exceedingly painful).

Perverted sensibility of the neck of the bladder, or neuralgia.

Incontinence of urine	{	in youth.
		in advanced age.

Habitual engorgement of bladder, and overflow of urine.

Retention of urine.

I. *Inflammation of the bladder (cystitis): acute.*—The seat of the inflammation is almost invariably the mucous membrane; occasionally, by intensity of the process, the cellular and muscular tissues external to it may be involved.

The mucous membrane, near the internal meatus of the urethra or neck of the bladder, is most frequently affected. It is so in that common form of cystitis, by extension from the urethra, in gonorrhœa. In the most severe forms the whole of the lining membrane is affected. This may be found after death simply injected and reddened, or thickened also; or more or less dark, of a chocolate hue, or even slaty

in colour, as happens when the action has existed for a long time. Occasionally lymph is exuded, and membrane-like patches, sometimes an extended layer, may be found adhering to the surface. In very rare instances such a false membrane has caused retention of urine, and necessitated puncture of the bladder in the male; in the female it is sometimes thrown off entire.

Causes.—The traumatic are numerous. Injuries such as blows and pelvic fractures; from lithotomy, lithotrity, and ordinary catheterism; injections; in the female prolonged and instrumental labours; mechanical irritation of calculus; the chemical action of some poisons, action of the urine itself, retained and decomposed, as in stricture and prostatic enlargement; inflammation of adjacent parts, rarely from external cold, and occasionally from gout.

Symptoms; of the graver form, occurring after operations and pre-existing chronic disease. The invasion is announced by rigors followed by fever. The desire to pass water is very frequent, sometimes uncontrollable; excessively painful, often accompanied by tenesmus. Pain is felt behind the pubic symphysis, in the perinæum and penis; in the sacrum and loins. There is tenderness to supra-pubic pressure, often on the lower half of the abdomen; felt also by rectal examination, still more by catheterism. The urine is at first high-coloured, scanty and clouded; then obviously reddish, soon muco-purulent and loaded with shreds; while the blood-tint deepens. Meantime the patient's condition becomes low; he is often delirious; and if the disease is not checked, he dies in from seven to fourteen days.

The symptoms of the milder form, which occurs by extension from gonorrhœa, are chiefly local. They are, painful irritability of the bladder, supra-pubic pain; pains in the sacrum, perinæum, and thighs; loss of appetite, but not always marked fever. The urine is cloudy, and deposits more or less mucus and pus. The most common termination is resolution; but in the more serious form described above, the whole of the mucous membrane is affected, and perhaps some of the tissues subjacent; it may also become ulcerated or gangrenous in the worst cases.

Treatment, of the milder form. A tolerably active mercurial purge at the outset. Leeches to the perinæum, if the attack is rather severe, followed by hot poultices, and perfect rest in bed. Hot hip-baths twice a day, 100° to 110°, or more. A moderate supply of diluent drinks, with liquor potassæ; no saline diuretics, but small doses of antimony, at the outset only, if severe. Hot linseed-poultices to the hypogastrium or perinæum. If the bladder is very irritable, half-drachm to one-drachm doses of the tincture of hyoscyamus every two or three hours; this failing, opium may be administered by mouth. As the acute stage passes off, buchu may be given, or small doses of tincture of iron. In the severe form, the treatment advised above is to be adopted at the commencement; but if symptoms of depression appear, support and alcoholic stimulants may be given, and large hot local fomentations, constantly maintained, should be substituted for the hip-bath; morphia, by the mouth, is usually necessary to tranquillise the system, with warm enemata daily, to unload the bowels. Retention must be watched for, and a soft catheter employed if necessary, but never unless it be really required.

Cystitis resulting from cantharides locally or internally absorbed comes on usually within two to four hours after the dose; the symptoms resemble those of gonorrheal cystitis, soon reach their maximum of intensity, and subside in from six to twelve hours. When at the worst, the spasmodic ejection of the urine, as soon as a few drops have accumulated in the bladder, is excessively painful. If the dose has been large, blood appears in the urine, but not otherwise; sometimes shreds of lymph also. The treatment consists in potash and full doses of hyoscyamus every half-hour for three or four hours, and perfect rest; all movements of the body aggravate the symptoms. It is highly important, if a blister has been the cause, to remove it at once, and to sponge the surface in order to detach every particle of cantharides remaining.

Chronic cystitis.—Of all urinary affections, this is one of the most common, and

its causes are numerous and varied. First, on the subsidence of the acute form, a chronic condition commonly supervenes, and may continue for a considerable period. Next, all forms of obstruction to the exit of urine produce chronic cystitis, by confining the urine until it becomes slightly decomposed, and consequently irritating to the bladder. Inability to empty the viscus, from paralysis or atony, when no obstruction is present, acts in a similar manner. If the urine is unduly acid or alkaline; if it be loaded with deposits from the kidney; if it be morbid, as in Bright's disease, or charged with irritating matters, such as diuretic salts, &c., chronic cystitis may be induced. Foreign bodies in the cavity of the bladder and tumours of all kinds, simple and malignant, give rise to it. Diseases of the rectum sometimes, such as piles, prolapsus, and cancer, those of the uterus also, by causing pressure, are recognised as causes. The bladder is sometimes, although rarely, displaced by adhesion to neighbouring parts, as to a portion of the lesser bowel; or may be forced into a hernial protrusion: in either case, if its contents are partially retained by pressure, chronic cystitis may be set up.

The structure affected is the lining mucous membrane, while the underlying fibres are often hypertrophied. Chronic or subacute cystitis appears in two distinct forms: the first, an ordinary inflammation, in which a more or less active hyperæmia, hypersensibility, and slight increase of secretion, are the main elements; the second, often a condition succeeding to this or to the acute form, in which a passive or congestive hyperæmia, and an *inordinate secretion of mucus* mingled with pus in varying quantity, mark the complaint. The latter form is popularly recognised as 'catarrh of the bladder,' and is sometimes called cystorrhœa.

The first, or *simple chronic cystitis*, is in fact the condition which exists in most cases of irritable bladder, be the cause what it may. Wherever undue frequency in micturition exists with increased mucous secretion from the bladder, however small the amount, there is present subacute or chronic cystitis. Pus also is always present, capable of being detected by the microscope, in these circumstances; and is therefore by no means a matter of grave import, as it is often taken to be. Any source of irritation in or near the bladder may give rise to subacute cystitis; and the cause being removed, the effects generally soon cease also. Ordinarily it ceases with rest, hot hip-baths, local fomentation, mild aperients, and sufficient alkali to neutralise the natural acidity of the urine, or nearly so, not to render it alkaline; if necessary, the use of buchu, triticum repens, cubebs, or copaiba, in small doses, may be adopted.

Chronic cystitis with increased secretion: catarrh.—Respecting the nature of the secretion, much difference of opinion has been manifested by different writers. Its naked-eye characteristics are well known: from urine which has been recently passed, a quantity of semi-transparent, tenacious, ropy material, very much resembling the white of an egg, is soon deposited: when poured off it first adheres to the sides of the vessel, but soon slides down in a mass resembling jelly, and then falls out suddenly. This material has been regarded by some as simple mucus; by others as prostatic secretion; and more recently as merely pus altered by an alkali. None of these descriptions appear to be correct. No doubt it contains an admixture of pus; but it is really a secretion resembling that from the bronchial membrane, of a homogeneous structureless fluid, containing numerous pus corpuscles, and young epithelial cells; but the proportion of the liquor to the corpuscles is much larger than in ordinary pus. The old term, muco-pus, describes it perhaps more correctly than any other.

Causes.—An attack of acute cystitis; permanent obstruction of any kind, causing retention, stagnation, and decomposition of the urine; calculi and other foreign bodies; tumours in the bladder; spinal paralysis, not only as a cause of retained urine, but as occasioning perverted action of the mucous membrane by impaired nervous supply; and all causes which produce a long-continued irritation of the organ.

Treatment.—The inflammation is of chronic and atonic character; and the treatment should be mainly tonic and astringent. It is also more topical than general,

since the remedies taken internally appear to act mainly by their local influence, impregnating the urine which is retained in the bladder.

1. *Topical treatment*, strictly so called. It is important that the urine, if alkaline, should not remain in constant contact with the diseased membrane. It is necessary to use a catheter first, to insure the complete contraction and evacuation of the bladder, if its own efforts do not accomplish this; and secondly, to remove morbid deposits by injecting warm water, and washing out the interior. This affords comfort to the patient; and still more if the water so employed contains some astringent or sedative agents. Of the former kind, one of the best is the acetate of lead, commencing with one-sixth of a grain to the ounce of water; next to this, the nitrate of silver, commencing with one grain to eight ounces of distilled water; or ten minims of dilute nitric acid may be used to four ounces of water. By slow degrees the nitrate may be increased as far as to one grain to the ounce in some obstinate cases with advantage. After washing out the bladder with plain water, at a temperature of about 100° (a gum catheter and india-rubber bottle, with nozzle and stopcock, is the best apparatus), about two or three ounces of the solution, not more, should be slowly injected, and be allowed to flow out. Two or three drops of carbolie acid to half a pint of water is a useful injection when the urine is fetid. Anodyne solutions also may be used, but are of small value.

All the manipulation connected with these processes must be of the most gentle kind, otherwise more harm will be done by the manual interference than good by the therapeutical element.

Counter-irritation is not very manageable in these cases, although sometimes useful. I have employed a Burgundy-pitch plaster, croton-oil in soap-liniment, and strong tincture of iodine, over the pubes; but prefer, as a general application to the pubes, a hot linseed-poultice, the surface of which has been sprinkled with mustard.

Pain and loss of sleep often demand the use of opiates either by mouth or rectum, and generally also such use of aperients as the system demands in consequence. Each case requires often a different treatment; some experiencing more relief from opium by the mouth, others from suppositories or small enemata. Subcutaneous injection of morphia is, I think, preferable for most patients.

2. *Internal remedies*.—Among the most popular are the infusions of buchu and uva ursi, and the decoction of pareira brava. The indications for their use appear to be the following: chronic mucous discharge from the bladder in large quantity, no inflammation being present, may be controlled by the astringent tonic uva ursi; or this agent may be employed with equal parts of decoction of pareira. Chimaphila is considered by some appropriate in this complaint. In this state also small doses of copaiba or oil of cubebs diminish the secretion considerably. When micturition is frequent, the urine is cloudy, and inflammation is present, a pint daily of decoction of triticum repens (two ounces to the pint), or a half-pint of the infusion of buchu during the same period, may afford relief. Dr. Gross recommends an infusion of one ounce and a half of the leaves of uva ursi, and half an ounce of hops, in two pints of boiling water; a wineglass to be taken several times a day.

Demulcents are useful and agreeable vehicles for the administration of acids, alkalies, and other agents, when these are required. Among the best are the decoction of marshmallow, or of the common mallow in its absence; of carrageen, or Irish moss; the infusion of linseed; the infusion of the bark of slippery elm; the decoction of barley, better known as barley-water; and a solution of gum arabic in water.

The alkalies and the acids are valuable remedies when appropriately given. The old rule of administering the former when the urine is too acid, and the latter whenever it is alkaline, is not to be followed. No doubt, when there is an excess of acid, it may be most effectually diminished and nicely controlled by liquor potassæ, and the alkaline bicarbonate, as well as by the tartrates and citrates. It is far less easy to neutralise the alkalinity of urine, the condition most constantly present in catarrh. Some benefit is, however, occasionally to be obtained from small doses of alkali, even when the urine is alkaline in the bladder. If the urine enters the bladder with its full amount of normal acid, or with excess, it sometimes irritates a vesical mucous

membrane in a state of inflammation. Hence Dr. O. Rees gives in such cases enough alkali, such as the citrate of potash, to neutralise the acidity of the urine; and in some cases much benefit is thus attained. Care must be taken, however, not to produce alkalinity of the urine, which it is our object to diminish. The mineral acids have little or no influence on the reaction of the urine. Large quantities of nitric or of hydrochloric may be given, without producing any result whatever. The benzoic acid is excreted by the kidneys, but a large quantity of this insoluble drug must be taken to acidify alkaline urine. Lemon-juice in full quantity has a similar effect. Alkaline urine chiefly depends on mechanical obstruction, and local treatment is mainly required.

In almost all instances, the patient should have light and nutritious diet; it is important to maintain the digestive system in good order, and to avoid obstruction of the abdominal viscera; thus an occasional dose of blue-pill is sometimes serviceable.

Suppuration of the bladder is that condition in which the catarrh is largely mixed with pus. It is to be treated chiefly with local mild astringent injections, and has been sufficiently considered with the last subject. The larger the proportion of pus in the fluid of catarrh, the graver is the existing affection.

Abscess of the bladder.—Occasionally deposits of pus occur in the walls of the bladder; these are always the result of pre-existing severe disease, usually chronic. Their existence is rarely to be diagnosed during life, and no special treatment is indicated.

Ulceration of the bladder.—This is a rare affection, and seldom occurs except in the last stage of urethrovesical disease, arising from obstruction, and after long-standing inflammation. It may occur also in tubercular and malignant diseases of the bladder; the ulceration following softening and disintegration of the deposit. A simple form of ulcer may occur from permitting a silver catheter to remain in the bladder with a large portion of the instrument within the cavity. Signs of ulceration are, blood in the urine, severe pain at a fixed spot, constitutional depression, usually soon ending in death.

Treatment.—Stimulants and support for the general condition; full doses of opiates, by mouth and rectum; small doses of alkali internally, and diluents; no unnecessary mechanical interference to be permitted.

Vesico-intestinal fistula.—Fistulous openings sometimes form between the bladder and some portion of the intestinal canal. The result is, that some contents of the latter enter, and produce much irritation of the bladder, and sub-acute cystitis. This is sometimes the earliest sign of the abnormal communication. If the urine is examined at an early period, fragments of vegetable and of animal fibre may be discovered under the microscope. I have been able to diagnose, in otherwise doubtful circumstances, the existence of vesico-intestinal fistula by this means. Usually the symptoms become gradually more severe, and faecal odour and colour are communicated to the urine. At length, considerable fragments of faecal matter enter the viscus, become partially dissolved there, and pass through the urethra. I have seen several cases of this distressing condition, both in the male and in the female, but chiefly in the former; and in these, carcinomatous disease in the abdomen has been the most frequent, but not the sole cause. Thus, adhesion may take place between an ulcerating bowel and the bladder; and the ulceration may extend into the latter, no cancerous disease being present.

Treatment.—The lesion having been determined, instrumental interference is—except for the purpose of removing foreign bodies from the bladder, which are a source of great misery—to be shunned. The use of purgatives is also to be avoided; but the bowels should be maintained in the natural condition. The food is to be such as will nourish the body without producing a large and coarse residue of faecal matter. In one case under my own care, in which a gentleman passed for several months the whole of the faeces by the urethra, great suffering was occasioned by swallowing indigestible substances, like grape-stones and husks. Subsequently, by

a careful selection of nutriment, the most painful symptoms were much ameliorated ; and washing out the bladder contributed to the patient's comfort. In this case the ulceration was not due to cancer.

For some of these cases of non-malignant disease another form of treatment remains. When the fistulous passage connects the bladder with the rectum, or with the sigmoid flexure, the propriety of opening the descending colon [Amussat's operation] ought to be considered. In one case, recorded in the 'Medical and Chirurgical Transactions,' vol. xxxiii., Mr. Pennell of Rio Janeiro did this with success, diverting the passage of fæces from the bladder by the artificial anus. Subsequently, Mr. Holmes achieved a similar success in a case in which the fistula was believed to exist low down in the colon (see the same 'Transactions,' vol. xlix. pp. 66 *et seq.*). More recently Mr. Bryant has reported two cases (in addition to a previous one) at the 'Clinical Society,' vol. v. p. 127, of successful issue to a similar proceeding for simple rectovesical fistula. The point to be determined before operating, is whether the communication exists between the small or the large intestine or the rectum, and bladder. If it is in the descending colon or below, urine will probably issue at some time or another per rectum ; if it is in the small intestine, no urine can issue by the bowels. In favourable cases, this proceeding should certainly be adopted.

Hypertrophy and sacculation of the bladder, dilatation, &c.—The muscular walls of the bladder become hypertrophied in most cases of obstruction near the outlet. Hence they become rugose and columnar ; and they may reach half an inch, and sometimes even an inch, in thickness. From the interlacing of the fibrous bands which constitute the parietes of the bladder, it often happens, when hypertrophy exists, that the mucous membrane is forced by pressure into the interstices between, and that gradually sacs are formed. These at first are very small, but if the action is continued and powerful, they become large and protrude beyond the periphery of the bladder, and form reservoirs for the urine. A sac may thus sometimes attain

the size of a healthy bladder, with a small orifice only opening into the original viscus. When large, its structure is chiefly mucous membrane and cellular tissue ; here and there a few muscular fibres sometimes cross the tumour. Sacs may retain calculi and stale urine, which thus becomes a source of irritation.

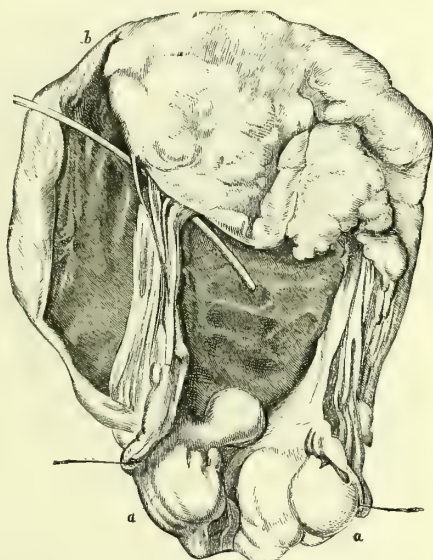
In addition to hypertrophy, the walls of the bladder are sometimes thickened by an interstitial deposit of lymph from inflammation, which impairs, and almost destroys, the muscular action of the viscus. Very frequently the bladder is simply dilated and distended, as a result of obstruction, the walls being thinner instead of thicker than natural. This condition occurs from the prostatic mass implicating the muscular apparatus at the neck of the bladder, preventing the viscus from contracting, and producing passive distension. Hypertrophy does not then take place, because muscular action is impossible, or nearly so.

Vesical hæmaturia. (See 'Hæmaturia,' p. 176.)

Tumours of the bladder consist of—

1. Fibrous growths, of a warty and of a polypoid character.

FIG. 29.—A large Sac projecting from the right side of the Bladder. The communicating orifice just admits a common quill. Cause, long-standing hypertrophy of the prostate, the thin portions seen to be enlarged below.



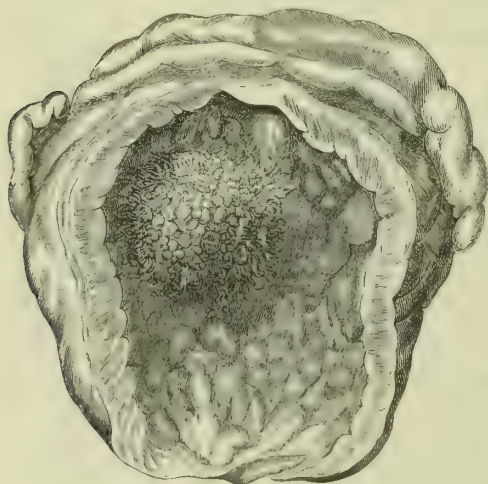
a, prostate gland divided ; b, cavity of sac laid open.

2. Villous or vascular growths.
3. Epithelial growths.
4. Malignant growths.

1. *Fibrous growths* are rare, and but few specimens are preserved in our museums. They are non-malignant, causing injury by causing cystitis and by the obstruction they occasion to the urinary outlet. They are connected with the mucous membrane and submucous tissue, and are made up of elements normally belonging to the latter. They appear to commence in the form of simple warty growths; which subsequently enlarge, and assume a polypoid form. They are totally different from uterine polypi, and from the outgrowth frequently found springing from the posterior part of the prostate.

The *symptoms* are those common to all forms of obstruction to micturition, added to the special signs of foreign body in the bladder; and the tendency to bleeding, more or less frequently occurring, aggravated by exercise. It has fallen to my lot to meet with a few cases observed at autopsy, but I have within the last two years met

FIG. 30.—Villous Growth. From a specimen in the author's possession.



with two examples during life and removed them by operation. One occurred in a male aged thirty-seven; the other in a female aged thirty. In each case the operation was perfectly successful. The first was presented by me, together with the patient, at the Royal Medical and Chirurgical Society in April 1882, eighteen months after the operation; and no sign of returning disease has appeared. The other, a patient of Dr. Philson of Cheltenham, I operated on three months ago, removing a large growth in the manner described at p. 194, under the head 'Digital Exploration of the Bladder in Obscure Cases of Bladder Disease.'

Treatment.—No special curative treatment is applicable in the male subject of these growths, except that of removal by operation.

2. *Villous growths.*—These have usually been classified as 'malignant,' but have no claim to be so considered. The villous growth of the bladder is a soft, flocculent body, about the size of a small strawberry when developed, made up of innumerable floating villous processes, branching from the base, which is connected solely with the mucous and submucous tissues. These villi are identical in structure with the villous processes of the chorion in its normal state, and are very vascular. Several such tumours may coexist in one bladder; and the whole or a large portion of the mucous lining of the organ may, if closely examined, be found studded with small villous processes, similar to those of the tumour itself.

The *symptoms* have nothing special to distinguish them from those of other tumours, excepting the frequent or almost constant appearance of some blood in the urine without provocation. Indeed, death occurs rather from hæmorrhage than from obstruction in these cases, as well as in part from the exhaustion which pain induces. Pain depends on the amount of obstruction occasioned; if the growth is situated so as not to hinder the outflow of urine, pain is not necessarily severe. Small shreds are found in the urine, which, under the microscope, indicate the nature of the disease. The growths are too soft to be identified by the sound, and instrumental interference almost always aggravates the symptoms.

Treatment.—The indications are, to allay pain, to subdue spasmodic action of the

bladder, to prevent hæmorrhage by internal remedies, and to counteract its effects on the system by chalybeates and nutritious diet. Astringent injections carefully introduced into the bladder, such as weak solutions of acetate of lead or of nitrate of silver, may be tried; they are, however, not to be repeated, unless marked benefit is observed, and signs of vesical irritation have not been produced by their employment. Their removal should be attempted in the manner already referred to.

3. *Epithelioma*.—This is a rare affection, and appears to be of slow growth.

A preparation which I exhibited at the Pathological Society was from the body of a patient who certainly had been the subject of it eight or ten years. In his case the symptoms resembled those of stone, only that the slightest degree of movement produced bleeding, in the later stage. Injections of nitrate of silver, from the half of a grain to one grain to the ounce, controlled this tendency remarkably, and enabled him to walk a mile or two without hæmorrhage. After death the same deposit was found in one kidney. ('*Path. Trans.*' vol. xviii. pp. 162-4.)

4. *Malignant disease of the bladder* is more frequent than the growths just described. Sometimes it is primary, commencing independently in the bladder; at other times it is secondary, extending from the prostate, from the uterus, or from the rectum. The species may be scirrhus, but is usually encephaloid when originating in the bladder; always the latter when spreading from the prostate; when from the rectum, it is commonly scirrhus; from the uterus, the same, or epithelioma. Colloid is said to have existed, but it is extremely rare. The disease generally runs a rapid course, and presents the constitutional characters significant of malignant action. In cases of encephaloid a large mass is soon formed, which sometimes almost fills the cavity of the bladder.

Symptoms.—A marked sign of this affection is hæmorrhage into the bladder, generally occurring suddenly and in large quantities, rather than by frequent oozing, which latter mode is more characteristic of villous growths. The pain is very severe, and is referred as much to the loins, back, and thighs as to the pubic and perineal regions. All the signs of obstructive disease and chronic cystitis are present. Glandular enlargements are usually distinguishable in an advanced stage in the iliac regions; and the patient wastes from loss of blood and rest. Small portions of tissue are often voided; occasionally cells may be found in the urine, which, when examined, indicate the nature of the disease; but the diagnosis is generally clear without support from this source; for too much stress must not be laid on the indications which cell-growths in urine afford as to malignant disease in the urinary passages. When masses of soft growth, however, are frequently passed, made up of large cells with more than one nucleus, the diagnosis of cancer is strongly confirmed.

The principles of *treatment* vary in no respect from those which have been laid down under the head of villous tumours. Opium in some form, most useful by subcutaneous injection, is of great value in alleviating the severe suffering; and must usually be given in the later stages with great freedom. In all complaints of the urinary organs where little can be done but to alleviate pain and support the powers of life, this remedy should be given with no sparing hand. So severe is the anguish which the patient suffers if left to the action of his complaint, unchecked or only partially checked, that it is cruel to deprive him of every aid to mitigate distress; while alcoholic stimulants also are in some cases scarcely less valuable than opium in enabling him to endure the progress of his malady.

Tubercle of the bladder.—This very rare affection probably never occurs unassociated with tubercular disease in other parts of the body; other parts of the urinary system are similarly affected, generally the kidneys and prostate. In women it has followed primary disease in the uterus. The disease commences by a deposit in the coats of the bladder of small tubercles; these become numerous and coalesce; subsequently the morbid material softens, the mucous membrane becomes ulcerated, a large extent of the inner coat being sometimes destroyed before death.

The symptoms of this disease are not peculiar, and the diagnosis depends rather

on negative than positive signs. The absence of much or frequent hæmorrhage may serve to distinguish it from malignant and villous tumours. Great pain and extreme frequency in making water, the absence of calculus or other foreign body, as ascertained by sounding, together with the presence of tubercle elsewhere, and progressive emaciation, and lastly the patient's age, usually early or middle adult life, will serve to indicate the true character of the disease.

Treatment.—That which is adapted for constitutional tuberculosis in relation to the general health. For the local complaint, anodynes, the remedies for chronic cystitis, rest; and no mechanical interference when the diagnosis is tolerably clear.

Bar at the neck of the bladder.—The enlargement of the prostate, common in old age, often produces an elevation of the structures, sometimes amounting to a distinct ridge, at the inferior aspect of the neck of the bladder. A bar may be thus said to be formed there; still it is not usual in this country to apply that term to any product of enlarged prostate; but it is reserved to denote any bar which is not prostatic in its character. Such occasionally exists in elderly subjects, as Mr. Guthrie was the first to point out. He believed the bar to consist in disease of 'the elastic structure' existing at the neck of the bladder, and as such to be quite distinct from the very common complaint already referred to. After considerable study of this question, I consider the non-prostatic bar as extremely rare, since almost all permanent obstructions at the vesical neck are due to enlargement of the gland or to its effects; nevertheless, in very exceptional instances the bar in question is undoubtedly to be met with.

Thus, in all long-continued diseases of the urethra and bladder, one may observe a hypertrophied condition of structures at the neck of the bladder, or bar, as its consequence; but this is not to be regarded as an example of the disease in question.

The treatment mainly consists in that for chronic cystitis, and passing a catheter if the bladder does not empty itself. Mr. Guthrie and others have proposed to divide the bar by incisions; but the entire subject of operations for obstruction at the neck of the bladder is considered at the close of the section relating to hypertrophy of the prostate.

Hernia of the bladder is rare but liable to occur in both sexes: in the male, as inguinal; in the female usually as vaginal, although it may be femoral. In the former it generally forms part of a large mass occupying the scrotum, pressure on which sometimes evacuates a portion of urine. It may be associated with hernia of the bowel, or it may exist independently: thus, it has been met with in the operation for strangulated inguinal hernia, and has been opened by mistake, as in one of the two cases recorded by Pott; but it is never covered by peritonæum. In cases which are detected early, a truss may be successful in retaining the viscus within the pelvis; when permanently fixed in the new position, support is to be applied to prevent further protrusion.

Inversion of the bladder is very rare, and found exclusively among female children. Three cases have come to my knowledge;¹ the condition always commencing at an early age. The bladder is gradually prolapsed and protruded through the urethra, which is much distended, and the viscus forms a pyriform, red, vascular tumour. Thus, one of these cases narrowly escaped the application of a ligature, but the orifices of the ureters were discovered, and reduction was accomplished by manual pressure. Considerable incontinence existed after reduction in two; but in the third it occurred to the surgeon (Dr. Lowe, of Lynn) to apply a heated iron to the urethra (in all five times), and to keep a silver catheter with a bulbous extremity in the bladder, between two and three weeks; by which the viscus was maintained in its place, and cicatrization of the urethra ensued: only slight incontinence remained.

¹ *Lond. Med. Gaz.* 1833, Jan. 19; *Trans. Prov. Med. and Surg. Assoc.* 1846, by Mr. Crosse, with plate; *Lancet*, 1862, vol. i. p. 250, by John Lowe, M.D.

II. *Conditions which do not involve obvious organic structural change.*

Paralysis of the bladder.—One of the most common terms used in relation to complaints of the bladder is paralysis: and most commonly it is incorrectly employed. Thus the bladder, when unable to evacuate its contents from obstruction by stricture, or by prostatic enlargement, or by atony from over-distension, is commonly said to be ‘paralysed,’ although there is no derangement of the nervous supply; to which last-named condition the use of the term ought to be limited. The bladder may possess its normal contractile power, but be unable to overcome an obstacle in the outlet, and so fail to expel its contents; the complaint in this case is not paralysis of the bladder, but solely obstruction in the channel of exit—two totally different conditions. This distinction must be clearly kept in view in our consideration of this subject.

True paralysis of the bladder is a condition in which the contractile power of its muscular fibres is lost or impaired from failure of nervous supply; thus there may be partial as well as total paralysis. The usual cause of this accident is cerebral or spinal lesion. It happens in some injuries to the brain, in almost all serious injuries of the spine, in softening, in apoplexy and in all serious organic affections involving those parts of the cerebro-spinal system which affect the urinary apparatus. It occurs from spinal debility produced by excesses, especially of a sexual kind; also in temporary functional derangement of the nervous centres; through the agency of reflex action from some adjacent source of irritation, as in hæmorrhoids, and especially after operations for their removal; and after other operations; although in some of these cases the retention is probably due rather to spasm of the constrictor muscles than to paralysis of the bladder. It may also happen after shock to the system from any source, in fevers, &c.

I have met with a single case of permanent loss of power in the bladder attributed to an overdose of belladonna. Certain it is that hyoscyamus and belladonna frequently produce temporary paralysis: and in this manner combat undue irritability of the organ, for which they are so constantly prescribed. I repeat then that there is no true limited or local paralysis of the bladder, either affecting the body of the organ alone, producing retention; or of its neck alone, producing incontinence; or of the entire organ, unassociated with paralysis of other parts or organs.

Treatment of paralysis.—Our first duty is to empty the bladder by the catheter twice or thrice daily, employing it with great care, for the patient has probably lost sensibility, and cannot indicate when injury is inflicted. A full-sized flexible or silver instrument should be used. If chronic cystitis appears, the appropriate local remedies must be employed, especially washing out the bladder by very mild astringent injections.

In cases not traumatic, or depending upon acute disease, strychnia, steel, cantharides, ergot of rye, and arsenic deserve a trial. Galvanism, cold douches, and blistering may also be employed as local agents.

Atony from over-distension.—Organic obstruction having existed at the neck of the bladder (enlarged prostate), or in the urethra (stricture), for a long time, the bladder fails to expel all the urine, and a portion is left behind at every act of micturition. This condition increases until the amount of ‘residual urine’ reaches twenty or thirty ounces or more; then some of it runs off involuntarily during sleep, or when any strong exertion is made. The fibres of the bladder, having been over-stretched, lose their tone, and, even on the obstruction being removed, cannot expel the contents of the viscus. A similar state may be produced from over-retaining the urine voluntarily, or by temporary spasm, or by some cerebral affection, in fevers and the like. Such is the condition termed here atony, and often falsely called paralysis, as already noticed in the preceding section.

Treatment.—It is essential, in the first instance, to insure the complete emptying of the bladder for a time, at least once or twice daily. The muscular fibres must be enabled to resume their normal condition of contraction from time to time; and this never can take place unless the bladder is artificially emptied. If the over-distension has not continued long, they gradually regain their tone, or recover part of it; but if the

contrary, it is rarely completely removed. Without mechanical aid medicine is absolutely useless, but in combination with the former, those general and local stimulants of nervous action, already advised in paralysis, should be employed in this affection also.

Irritable bladder.—A term often loosely employed to designate a specific affection of the bladder. Like the term ‘dropsy,’ ‘irritability of the bladder’ denotes only a symptom; in this case meaning simply that the patient passes urine too frequently. Irritability is present in almost every affection of the urinary organs, from childhood to old age; and it is named here solely on account of the conventional misappropriation of the term, and for the purpose of protesting against it. Nevertheless, nothing is more common than to be asked, even in professional communications, what is the best remedy for ‘irritability of bladder.’ Denoting no special pathological state, the other symptoms associated with it must be considered before a diagnosis of the existing complaint can be made.

Spasm of the bladder describes another symptom, but this term is less frequently misapplied. It implies that the contractions of the bladder are involuntary, uncontrollable, and exceedingly painful, the cause usually being inflammation, stone, foreign growths, &c. As in the preceding instance of ‘irritable bladder,’ it is often employed to denote a specific affection when the true disease has not been discovered; but the existence of some exciting cause may be predicated as invariable. Spasm is allayed, whatever the cause may be, by general and local anodynes, anæsthetics, and anti-spasmodics, as described under the head of treatment for cystitis, prostatitis, and stricture, with which conditions it is liable to coexist.

Perverted sensibility of the neck of the bladder, or neuralgia.—A few cases of severe urinary symptoms are met with in which neither researches during life nor inspection after death reveal the nature of the affection. But the number of instances admitted to this category diminishes in direct proportion to the degree of skill in diagnosis which is brought to bear on obscure cases. Usually the patient complains of symptoms greatly resembling those of stone, but repeated soundings fail to detect it, or any other deviation from the normal state. The urine is healthy, or contains only traces of undue action of the mucous membrane. Errors in diet sometimes aggravate the symptoms, sometimes have no effect. Change of air and scene often produce an improvement, which unhappily is only temporary. By careful investigation, a deranged state of the liver, early stages of renal disease, the presence of hæmorrhoids, commencing cerebral changes late in life, or miasmata, may be found to account for some cases; but nevertheless a few remain apparently inexplicable. Such have been regarded, for want of more certain knowledge, as examples of ‘neuralgia of the neck of the bladder.’ The treatment of the general health, and against periodicity of attack, if such be present, is indicated in such cases. Palliation of severe pain is to be obtained by the usual remedies.

Incontinence of urine.—An involuntary flow of urine may occur under two widely different conditions: the first, during sleep only, in young subjects, the bladder emptying itself when the control of the will is suspended; the second may occur in adult subjects of all ages, when the bladder is over-distended with urine; a certain quantity, usually in some proportion to the quantity retained, running off either during sleeping or waking. The following rule almost invariably holds good: in juvenile incontinence there is no retention of urine; in adult ‘incontinence’ it is present to a serious extent. There is no principle more important to remember in the treatment of diseases of the urinary organs than this, viz. that an *involuntary flow of urine in the adult indicates a distended, not an empty bladder.*

1. *Incontinence in childhood and youth.*—This is a common and sometimes a very troublesome infirmity, affecting children and youth, although occasionally it continues even after puberty. The single symptom is that in the course of the night the patient wets the bed without awaking, once or more before rising. Sometimes this occurs every night; sometimes there is an interval of one or two nights, rarely of more. The patients so affected do not appear to belong to any particular temperament, nor to be necessarily weak and cachectic. In some the habit results from neglecting to

take up young children once during the long period which is necessary to them as a night's rest. In such cases attention to habits and diet may arrest the infirmity. In many cases, however, no ordinary management succeeds, and medical aid is sought.

Innumerable remedies have been given, and with a very unequal success. Small doses of cantharides and of strychnia, either with or without iron, are sometimes employed. Tincture of iron alone, or the *vinum ferri*, has sometimes proved successful. Blister to the sacrum has been a favourite remedy; also cold douches to the spine, and general tonic treatment in most cases. In my own experience, nothing has afforded such good results as the tincture of belladonna, giving at first, according to the age of the patient, ten to twelve minims twice a day, and increasing the dose if required as far as it can be safely borne. Disappointment often arises from deficient quality in the drug.

In cases of extreme obstinacy I have succeeded by applying a solution of nitrate of silver, ten grains to the ounce, to the prostatic portions of the urethra and neck of the bladder: a remedy applicable in either sex.

In no cases is it desirable to employ mechanical pressure to prevent micturition. By some of the agents already named, or by the improvement of the health, in which may be included the removal of worms, and other sources of intestinal irritation, success is almost always ultimately attained.

2. *Incontinence in the adult* indicates, in the vast majority of cases, a bladder distended by retained urine; the cause of which may be stricture, enlarged prostate, cystitis, stone, atony, or true paralysis. It very rarely happens in the male that the urine leaves the bladder as fast as it arrives from the kidneys. Hence it is a cardinal principle that whenever urine runs off incontinently, a catheter should be passed to ascertain the amount of retention present, and to relieve it. In the female, true incontinence is more frequent, and is generally caused by injury to the urethra, which has impaired the sphincter's action, such as sloughing from pressure in labour, from the use of obstetric instruments, from over-distension of the urethra in removing calculus, &c.

Treatment.—It is unnecessary to recapitulate that which relates to the various conditions above mentioned, since they have been considered under their various headings. When true incontinence is really present, the cause is to be sought either in some perverted action of the nervous centres, or in a very rare form of prostatic enlargement in which incontinence does occur. Supposing no local organic disease is found in the urinary organs, a careful investigation of the cerebro-spinal system must be instituted, and if the origin be found there, the general treatment must consist in that which the affection indicates, besides the employment of local appliances to protect the patient, such as a well-adapted urinal. Where incontinence results from functional derangement, caused by excess, the cure will be effected by any means which restores tone to the spinal system. For this object preparations of steel and zinc, of strychnia, with quinine and other vegetable bitters, are of value. Nutritious diet, cold sea-bathing, and abstinence from causes of debility previously acting, form also a part of the treatment. The local alteration of structure, which very rarely occasions incontinence, is a form of the prostate, in which the posterior portion ('third lobe') is much hypertrophied, and projects forward in the manner of a wedge between the two lateral lobes, so as to open out the neck of the bladder and render it constantly patent; instead of projecting backwards into the cavity, as almost invariably happens, and forming a species of valve which prevents the outward flow of urine.

Habitual engorgement of bladder, and overflow of urine.—These terms more correctly describe the conditions met with where urine passes involuntarily than that of 'paralysis,' already referred to. Obstruction having existed for a certain period, the bladder is unable to overcome the obstacle and empty itself; so that a certain portion of the urine remains after every act of micturition. This failure, once established, gradually increases; the remaining quantity of urine becomes larger; the viscus is habitually engorged, it coats are thinned and atonied, its neck is dilated, and

as a portion runs off irrespective of the patient's will, brief temporary relief is afforded. This overflow occurs first during sleep, and subsequently from pressure of the abdominal muscles when any efforts inducing their contraction are made. Unless this state of things is remedied by treatment, the result is chronic inflammation of the bladder, with a tendency to spread upwards to the ureters and kidneys.

The treatment of engorgement and overflow consists in emptying the bladder from once to three or four times in the twenty-four hours, according to the necessities of the case, and in using those remedies which the amount of chronic cystitis, almost always present to some extent, indicates to be necessary (see '*Chronic Cystitis*,' p. 184).

Retention of urine (see '*Stricture*').

OBSCURE CASES OF CHRONIC BLADDER DISEASE; DIGITAL EXPLORATION OF THE BLADDER.

It not unfrequently happens, however great may be our experience, that a case presents itself, relative to which, after careful examination, the cause of the symptoms is obscure. Generally, but not always, it can be stated whether the chief source of them is situated in the bladder itself, or altogether in front of it, or altogether behind it; in other words, whether the situation of the disease be vesical, post-vesical, (kidneys and ureters), or anti-vesical (prostatic and urethral).

In arriving at a diagnosis, we have in the majority of cases to determine—

1. Is there any inflammation—gonorrhœal or other—of the urethra, or of the prostate, implicating, in a secondary degree, the bladder; such conditions being generally present in younger subjects?
2. Is there obstruction in the urethra—stricture; or at its junction with the bladder, prostatic—causing cystitis; such diseases more commonly existing at or after middle age?
3. Does the bladder empty itself by its own efforts; failure even in a slight degree being a very common vesical cause of cystitis in elderly male patients?
4. Is there a calculus in the bladder?

If all these conditions are absent, and no evidence of renal disease exists; and yet distressing symptoms, such as frequent micturition, pain, and bleeding are manifest and long continued, we naturally speculate with some anxiety as to the presence of tumour or some other unusual condition of the bladder. It is to aid in achieving a diagnosis of this group of obscure cases of vesical disease that the present mode of examination is proposed.

We have been long accustomed to use catheters and sounds of various forms, as well as the flat-bladed lithotrite, for the purpose of diagnostic examination of the bladder. They are used as necessary substitutes for the finger—I have often spoken of them as becoming prolongations of that organ—and they suffice for our purpose in the vast majority of cases. Of course one would prefer the direct sensations acquired by touch to that substitute for them which is transmitted through a metallic conductor such as a sound. Nevertheless, it is the finger itself which may sometimes be advantageously employed in exceptional cases, where by means of sounds and the like we have failed to discover the nature of the malady. The direct application of the finger is not only possible, but is moreover neither a difficult nor a dangerous proceeding; and it is not only a promising means of prosecuting diagnosis in exceptional cases, but is likely to constitute an efficient mode of treatment for some of them. I have been accustomed to use the index-finger as much as possible in lithotomy in its several forms—lateral, median, bilateral, and medio-bilateral—and have been in the habit of examining the neck of the bladder, and scrutinising, with much interest, its characters, often greatly differing as they do in the cases of elderly men. But it is only during the last few years that I have gradually realised the fact that it is possible, in not a few cases, to explore through a small perineal incision the whole, or nearly the whole, of the internal surface of the bladder with the index-finger. A necessary condition, of course, is that the bladder should be empty; and in that condition it is—as is sometimes perhaps not sufficiently recognised—no longer

a cavity, as represented in diagrams, but a mere cul-de-sac at the end of the urethra. Taking it for granted that the incisions to be made, which involve only the urethra with the tissues between it and the surface, and not at all the bladder and prostate, enable the operator to place the last joint of his left index-finger within the neck and thus to draw it somewhat towards him, the exploration may be accomplished in the following manner. Maintaining his finger at the spot described, the operator should stand up at the foot of the table, a little to the left of the patient (who is in the lithotomy position), so as to make firm pressure with the right hand above the pubes, the resistance of the abdominal muscles being overcome by the influence of ether. He may now easily feel, unless the patient be very stout, the opposite side of the bladder coming into contact with the tip of his finger; and by concerted movements of supra-pubic pressure by the right hand, with slight movements of the left index in the bladder, almost every portion of the internal coat of the latter may be brought under examination. If the patient be thin, the proceeding is easy; it becomes less so in proportion to the depth of perinæum and thickness of the supra-pubic coverings, both of which are increased by fat. In the latter case aid may be rendered by an assistant, who makes firm pressure with both his hands, but the operator should also employ, if he can, the concerted movements described.

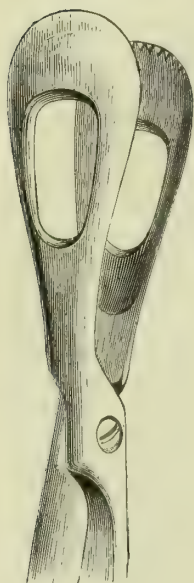
The question now arises, Can such digital exploration of the bladder be performed without much risk to the patient? It may be unhesitatingly answered in the affirmative. I have so frequently opened the urethra from the perinæum, chiefly in conditions connected with stricture, besides a few times for the purpose now under consideration (making, with occasional variations, the incision so long known in French surgery as '*la boutonnière*'), that it may be said with confidence that the operation is almost free from danger. When the operation of median lithotomy is performed, the chief risk is due, not to the incision, but to the injury done to the neck of the bladder by seizing and withdrawing the calculus. It is in fact the forcible removal of the calculus and not the action of the knife which, as a rule, makes lithotomy a grave operation. The question of the best method of reaching the bladder for our purpose naturally follows. I think there is little ground for doubting that a vertical median incision—that is, in the line of the raphe—introduces the finger by the shortest and most direct route. The prominence formed by the operator's bended knuckles, while using his index-finger as an explorer, lies equidistant between the nates, and is firmly pressed on the perinæum in a straight line from the external surface towards the centre of the bladder. Any line right or left of the median must of necessity lead obliquely to the centre, and be a longer line, because it commences at a point on the external surface more distant from the neck of the bladder than is the raphe of the perinæum. Accordingly I always adopt the central incision, using a median grooved staff, and a long, straight, narrow-bladed knife, with the back blunt to the point. Having placed the left index finger in the rectum, the knife may be introduced, edge upwards, about three-quarters of an inch above the anus, with or without a small preliminary incision of the skin (I prefer the former), until the point reaches the staff about the apex of the prostate gland, where it divides the urethra for half an inch or so, and is then drawn out, cutting upwards a little in the act, but so as to avoid any material division of the bulb. The left index-finger is now removed from the rectum, and, following by the groove of the staff, slowly passes through the neck of the bladder as the staff is withdrawn, when exploration is made, as described above. A moderate division of the bulb when made in the middle line is not to be feared as a cause of hæmorrhage, while an incision involving the side of the bulb, and nearer to the entry of its artery, is more prone to bleed freely. Hence some have preferred another mode of incision in order to avoid it—namely, one of crescentic form, with the convexity upwards, just above the anus; the dissection to be carried transversely to the apex of the prostate, and opening the urethra there, as before mentioned: an incision somewhat resembling the commencement of Dupuytren's bilateral operation, but more limited in extent.

A similar exploration may be made in women, but with greater ease. All that is necessary is to dilate the urethra slowly and carefully by means of the three-bladed

dilator, until the index-finger can be introduced; in this manner no permanent injury results to the passage.

For removing growths within the bladder I have designed and employed two forms of forceps somewhat like those used for extracting the stone. In each the extremities of the blades meet, when the handles are brought together, not with sharp edges for cutting, but on wide surfaces roughened so as to compress and disintegrate the tissues involved; to produce such a division of the structures as shall hinder the occurrence of bleeding as much as possible.

FIG. 31.



The larger forceps (fig. 31) are adapted to all masses springing from the posterior and lateral aspects of the bladder; the smaller curved forceps for portions adjacent to the neck of the bladder.

THE PROSTATE.

Malformations.—There are no special malformations to be noted here, except such as are involved in the condition called ‘*extroversion of the bladder*,’ which see (p. 181).

Injuries (see vol. i.).

Inflammation of the prostate } acute,
(*prostatitis*), } chronic.

Abscess of the prostate.

” ” periprostatic.

Hypertrophy and simple tumours.

Atrophy.

Malignant disease.

Tubercle.

Cysts.

Acute inflammation of the prostate.—This affection is generally associated with inflammation either of the urethra or of the bladder. It may be secondary to cystitis, but more frequently owes its origin to gonorrhœa, which has extended to the prostate, and to the bladder also. Sometimes it appears as a purely idiopathic occurrence and not by extension; but this, excepting the cases produced by violence, as by instruments, &c., is probably extremely rare.

Causes.—The pre-existence of acute inflammation of the urethra, especially gonorrhœal; aggravated stricture of the urethra; the application to the prostate of strong injections, cauterisation, the passing of sounds, and mechanical violence of various kinds; inflammation of the bladder, and calculi. Cold and damp to the perineum may occasionally give rise to it. Inordinate sexual excitement, urethritis already existing, is also a cause.

Symptoms.—A sensation of weight and fulness about the rectum and perineum, with uneasiness at the neck of the bladder; then undue frequency of micturition and pain at the close of the act; the latter becomes severe, throbbing, and almost continuous; a sense of great tension is experienced about the anus and perineum; pain also in the back and loins is complained of. The action of the bowels produces distress; and a finger introduced into the rectum finds the anterior wall prominent, hard, and hot, and the prostate larger than natural; while piles may be found present. If a catheter is passed, excessive pain is felt when the instrument reaches the prostatic urethra. At a later stage, suppuration may take place, and micturition becomes difficult, and even total retention may be produced by the swollen prostate. General fever, mostly commencing with rigors, accompanies these symptoms. Pus usually soon appears in the urine, and if there has been abscess, a large quantity suddenly escapes by the urethra, with great relief to the patient.

Treatment.—The bowels should be freely opened at the outset, and a gentle action upon them maintained afterwards; then a little antimony and full doses of alkali should be taken, such as the bicarbonate or acetate of potash. Local bleeding often

gives more relief than anything else; from ten to twenty leeches should be applied to the perinæum and around the anus. Then a hot hip-bath should be taken, followed by a large poultice on the perinæum, and the patient be wrapped up warmly in bed. The bath may be frequently repeated with advantage; and if retention of urine occurs, and does not yield to hot fomentations and opium, a soft *coudée* catheter should be passed, and the bladder relieved. The instrument is to be withdrawn at once, and used again if necessary (see 'Retention of Urine').

In a few days the severe symptoms generally subside, but sometimes relapses occur. These are mostly attributable to indulgence by the patient in stimulants, exercise, or erotic excitement. When convalescence is established, the prostate may still be enlarged and hard, and the stream of urine is not propelled with its natural force.

Chronic inflammation.—The prostate is sometimes enlarged, but not invariably; when occurring as a sequel to the acute attack, it is always so. The symptoms are: Diminished force in propelling the urine; some gleety discharge; urine cloudy and depositing pus; after passing it, a drop or two of blood may follow. There are weight and dull pain in the perinæum; pain in passing water; and sometimes, but not as a rule, frequent nocturnal emissions. The bladder is irritable, and all the symptoms generally aggravated by exercise and errors in diet.

Treatment.—One of the best means is counter-irritation of the perinæum by acetum lyttæ, kept up for some weeks. Tonics and good diet, with attention to the digestive organs, are mostly indicated; these latter being in fair condition, iron is beneficial; to be combined, when necessary, with some laxative. When nocturnal emissions are frequent, especially if they occur without consciousness on the part of the patient, the application of a solution of nitrate of silver, from ten to thirty grains to the ounce, to the prostatic part of the urethra, is one of the best means of treatment. To be successful, an efficient instrument is necessary, as well as care to inject the fluid at the right spot: three or four applications may be requisite. Let it be remarked, that the existence of chronic prostatitis is not to be inferred because the patient is subject to frequent seminal emissions. These occur from other causes, which have no connection with disease of the prostate, and need not be considered here.

When enlargement only remains after acute inflammation, the iodide of potassium may be given for a time. Then a course of tonics, steel and quinine, with sea-bathing and generous diet, often completes the cure.

Abscess of prostate.—Acute inflammation occasionally results in suppuration of the organ. This may be suspected when the acute symptoms do not soon subside, when pain and difficulty in micturition and defæcation increase, if rigors occur, and the patient complains of tension and pulsation in the perinæum or neck of the bladder. Fluctuation may be felt per rectum; or pressure may reveal tenderness in the perinæum. The natural course of abscess in the prostate is evacuation by the urethra; occasionally by the rectum, a route perhaps as favourable; and the opening of the abscess usually soon closes; if not, the cavity may remain open, become a receptacle for urine, and give rise to fresh abscesses in the vicinity.

In treating such a case, we should watch for signs of matter in the perinæum; and if present, make an incision boldly in the median line, to evacuate it. If successful, the patient will be greatly benefited; but if no pus is encountered, no harm results, while the pain and tension are probably diminished. Occasionally puncture of the abscess has been made in the rectum when fluctuation has been distinctly felt there.

An abscess of the prostate is sometimes followed by long-continued suppuration. Chronic abscess may occasionally arise spontaneously, from confirmed or neglected stricture of the urethra. When this has occurred, the cavity sometimes enlarges, urine makes its way into it, fresh irritation is maintained, much of the prostate is destroyed; and its capsule becomes the sac of a pus-secreting cavity; some-

times the one side or lobe only is involved. This condition, happily rare, is always serious, and its existence is often not suspected during life. The symptoms of chronic cystitis, emaciation, often hectic, are present; and a highly tonic and soothing regimen is usually indicated. Injections of nitrate of silver, of half or one grain to the ounce, are sometimes useful; but no local interference is desirable which gives much pain, or even temporarily aggravates the symptoms.

Abscesses supposed to be prostatic are not unfrequently external to the prostate, and not within the envelope of the organ; and are, in fact, periprostatic. They arise much in the same manner as prostatic abscesses, but are of less serious import. The treatment requires early incision, and does not differ from that just described.

The organic enlargement of the prostate of advanced age (hypertrophy).—This common affection seldom occurs before fifty-seven or fifty-eight years of age; I have never known a true example of it before the age of fifty-four years, and such an instance is very rare. Inflammatory enlargements occur at any age after puberty; but hypertrophy is wholly distinct from any inflammatory state. It has been said to be the common inheritance of old age: on the contrary, it is a complaint which a large majority of elderly men escape. In order to ascertain the frequency of its occurrence, I dissected out with great care the prostate in forty-three elderly individuals; and found that appreciable enlargement existed at the rate of thirty-two per cent.; notable enlargement, causing symptoms during life, at the rate of twelve per cent. The oldest individuals of the series were among the unaffected; including one at ninety, one at eighty-five, and two at seventy-nine years. Subsequent more extended researches by Dr. Messer and myself confirmed these results.

The enlargement consists mainly of an over-development of constituent tissues of the normal structure of the organ itself, some of which may be fully or only imperfectly developed. The two lateral lobes of the prostate may in this manner be increased to four or six times their natural weight and bulk; or an outgrowth may take place from the central part of the organ, in a backward direction, towards the cavity of the bladder, as a rounded or pyriform tumour, constituting what is frequently, but not very correctly, called the enlarged 'third lobe'; generally, however, every part of the organ partakes more or less in the enlargement.

Again, it is very common to find independent and isolated tumours of the same material embedded within the prostatic structure proper. On making a section with a sharp knife of a prostate so affected, these small rounded bodies are easily divided, and the portions may be removed by the finger-nail. The presence of these small tumours is extremely common in the enlarged prostate, as well as in the healthy organ in advanced life, and they seem to bear a relation to the containing organ somewhat similar to that which the uterine fibrous tumours bear to the uterus. In both cases they are composed mainly of unstriped muscular tissue, and exhibit other points of analogy in their nature and history.

The most important result of enlargement is obstruction to the flow of urine. Its first effect on the prostatic urethra is often increase of its antero-posterior diameter with diminution of its lateral diameter, the canal becoming a narrow passage, instead of one which, when distended, is of about equal diameter in every direction. The length of the prostatic urethra is also increased, and often tortuous: thus I have seen a urethra measuring four inches from the orifice of the bladder to the membranous portion, instead of one inch and a half, which is the normal length. So also, where there is enlargement of the median portion, the urethra suddenly rises, so that a complete step has to be surmounted at the neck of the bladder before an instrument will enter the cavity. When there is also much enlargement of either lateral lobe, the direction of the canal is changed. Thus, if the right lobe predominates, there will be a curve to the left, and *vice versa*.

The form of the internal meatus, or vesico-urethral orifice, may also be changed, or it may be overlapped by an outgrowth from the median portion of the form of a valve, which sometimes appears to be forced against the neck of the bladder by the effect of micturition, and the obstruction rendered still more complete.

The size and weight attained by hypertrophied prostates are remarkable. A prostate measuring two inches in a transverse direction, and one inch in thickness from before backwards, or which weighs an ounce, must be considered hypertrophied,

FIG. 32.—An example of greatly enlarged Prostate, the increase in size being mainly due to the fibrous tumours described; opposite *a*, *b*, and *c*.

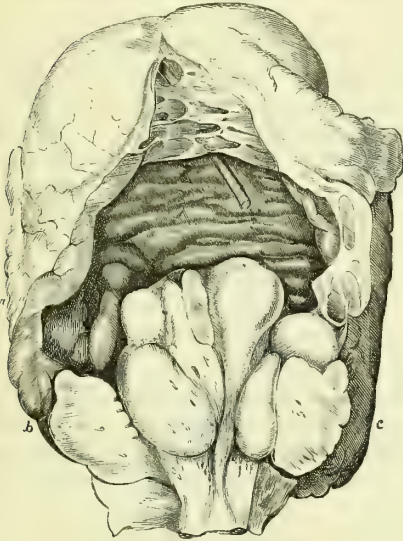
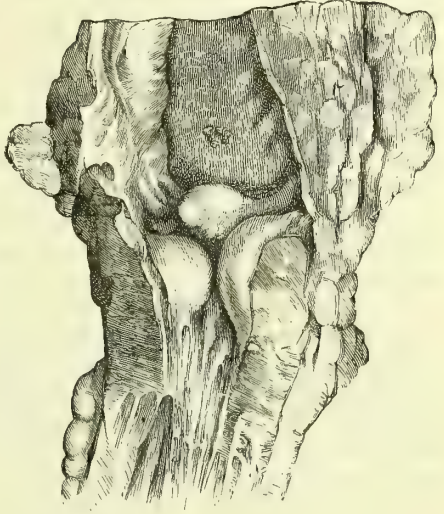


FIG. 33.—Hypertrophy of the Prostate affecting equally the lateral lobes and median portion: a typical example of the usual condition in a moderately advanced case.



but a transverse measurement of three inches is not uncommon. I have seen one exceeding four inches and a quarter; but such a degree of enlargement is extremely rare. The weight has been known to reach twelve ounces. In malignant disease even these limits are exceeded.

The consistence of the organ varies, being sometimes harder, at others softer than in the natural condition: in the former case there may be fibrous tumours embedded in its substance.

Symptoms.—In the earliest stage there is nothing to attract attention, a considerable period usually elapsing between the actual commencement of enlargement and the occurrence of any marked symptom. One of the earliest signs is diminution in the force with which urine is ejected, the stream is not necessarily much smaller than in health, but cannot be projected so far by any effort. Micturition becomes more frequent than natural, and the relief afforded by it is less complete. On rising in the morning, the bladder having been distended during sleep, the difficulty is often greater; and in course of time sleep is disturbed by frequent calls to pass water. A sense of weight and uneasiness about the perinaeum and rectum is felt, which the patient soon refers to the neck of the bladder. As the expulsive efforts become more frequent, the contents of the bowel are evacuated from inability to prevent the act of defaecation accompanying that of micturition; and prolapsus, or hæmorrhoids, are apt to result. Much stress has been laid on the appearance of flattened stools as an indication of enlarged prostate, but without sufficient grounds. As the complaint advances symptoms of chronic cystitis appear, pains sometimes in the penis and testicles, and occasionally muco-purulent discharge from the urethra. As relief to the bladder becomes less complete, it is never emptied, a certain portion of its contents only being expelled at each act of micturition. These difficulties, if unrelieved, inevitably increase; the capacity of the bladder yielding to the constantly augmenting pressure upon it. Hence in time the organ remains habitually filled, and the surplus only flows off at each act of micturition. At night, when voluntary control is suspended by sleep, urine drains away, to the great discomfort of the

patient. This condition is generally described as 'incontinence'—a bad term, since the true condition is one in which the bladder *retains too much*. A sign which should be looked for in such cases is dulness on percussion above the pubes, which is sometimes found as high as the umbilicus, although more frequently to the extent of only three or four fingers' breadth above the pubes; and there may be a good deal of urine retained with very little dulness to be noted.

As the complaint advances, the patient's health deteriorates, while slight irregularities, or exposure, may increase the severity of the symptoms, and an attack of complete retention may readily be induced.

The characters presented by the urine are such as depend on decomposition of some of its constituents from abnormal retention, mixed with the products of chronic inflammation of the bladder. More or less of mucous deposit slowly falls to the lower part of the vessel, sometimes in great quantity, and appears as the glairy, tenacious, slimy, adhesive matter so well known to be associated with chronic inflammation of the bladder.

The chemical reaction of the secretion is at first neutral, then alkaline in various degrees of intensity. The odour is pungent, ammoniacal, often fetid, sometimes extremely so; the quantity passed is sometimes below, but more generally much above, the natural or healthy standard.

As a result of these changes the formation of calculus sometimes takes place. Its presence will be suspected if there is much pain about the neck of the bladder at or following the act of micturition; if the pain at the end of the penis is unusually severe, and if the blood and pus are observed particularly after exercise, and especially if fragments of calculous matter have from time to time been passed. But the existence of calculus is sometimes masked by prostatic disease, because the foreign body lies back deeply behind the enlarged organ.

It not unfrequently happens that symptoms of enlargement exist long before the real cause is suspected: the frequency of micturition suggesting that there is undue freedom rather than obstruction to the act. The march of events, however, ought soon to throw suspicion on the state of the bladder; and if a catheter is passed, it often happens, to the astonishment of the patient, that several ounces of urine, or a larger quantity, may be drawn off, notwithstanding that the act of micturition has been just performed.

The last stage of unrelieved disease is indicated more by the signs of a gradual decline of the powers of life than by those of advancing obstruction; although sometimes the final symptoms are those of rapid depression, after sloughing or ulceration of the bladder, and repeated hæmorrhage, or from great discharge of pus from its cavity; rarely there is uræmic poisoning from failure of the eliminating function of the kidney.

Diagnosis.—The test which is chiefly depended on by the surgeon is digital examination by the rectum. For this purpose, the patient should lie on his back upon a couch, the surgeon introducing the forefinger of either hand into the rectum, while the other hand is free to use a catheter, if required, since by concerted movements of that instrument in the urethra, and of the finger in the rectum, more accurate information may sometimes be obtained than by either exploration conducted separately. The patient's knees being drawn up and separated a little from each other, the finger should be made to glide slowly through the sphincter, and when introduced as far as possible, so that two phalanges are free to move in the bowel, the limits of the prostate may be defined.

If familiar with the normal conditions of the organ, he can thus observe its size and form; whether the enlargement affects one or both lobes, and to what extent. It is so prominent sometimes that the finger encounters the swelling at once, and has to be depressed considerably before it can be carried farther. Instead of finding the yielding coats of the bladder in the middle line when the finger is carried up to its fullest extent, an increasing firmness may be encountered, due to an enlargement or outgrowth from the median portion. The form of the enlargement may not be uniform but irregular in outline. Then he observes whether the tumour is soft,

hard, or unequally so in places; whether there is fluid in it, and whether he can appreciate fluctuation distinctly beyond it—an important consideration in a case of retention which may require the trocar. If inflammation is present, the pain will be extreme, and the mere introduction of the finger will be very distressing to the patient; in this case, heat and tension will be remarked also.

Next, the urethra is to be explored with an ordinary full-sized catheter; and if by rectal examination no variation has been found in regard of size, and the urine flows when the catheter has traversed the ordinary distance, say from six to seven inches, we may be satisfied that no great prostatic enlargement exists. But if a silver catheter has passed easily, say for eight or nine inches, and still no urine flows; and if, in this course, the handle has become unusually depressed, there will be little doubt of the existence of prostatic enlargement. The ordinary catheter being inadequate to reach the bladder, a prostatic catheter, which measures from two to four inches longer, and has a larger curve than the ordinary catheter, may be employed. In some few cases, while the beak passes through the prostatic part of the urethra, the handle will be distinctly deflected to the right or left, from which fact enlargement may be suspected to exist on the side *towards* which the handle turns.

For more precise diagnosis, we must employ an exploring sound with a short curved beak at its extremity (see fig. 34). After the bladder has been examined, the instrument should be gently withdrawn until the beak lies just within the urethro-vesical orifice, when, by rotating the instrument on its axis, the condition, if natural, of that part can be ascertained; or, on the other hand, the presence of tumour or of stone, the depth of the fossa behind the prostate, and other points, can be determined. A light, delicate, and practised hand is necessary for this purpose.

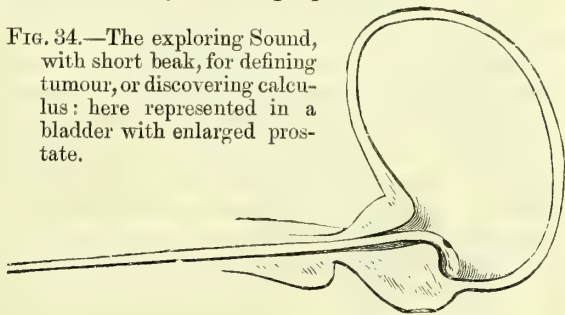
I shall here add a few remarks on the diagnosis of prostatic enlargement from stricture of the urethra, vesical calculus, tumour of the bladder, simple atony or inertia of the coats of the bladder, and paralysis.

In stricture of the urethra, the stream of urine is invariably small, in a confirmed case extremely so; in the prostatic affection, the stream, though diminished in force, is less so in volume than in the previous case. The use of a full-sized sound, however, marks the distinction clearly. In stricture, obstruction is encountered almost invariably before six inches of the instrument have disappeared, always before it arrives at the prostatic urethra. In enlarged prostate, obstruction is not encountered until seven, eight, or nine inches have passed, and not necessarily then, for, provided that the instrument be sufficiently long, it may pass into the bladder; but the handle has to be depressed between the patient's legs in a manner not required in the normal state. Lastly, stricture almost invariably makes its appearance before middle life, prostatic hypertrophy not until that period is passed.

In regard of calculus, while many of the symptoms are common to both complaints, the occurrence of severe pain at the close of micturition in the end of the penis, the aggravation of symptoms after exercise, especially of pain and bleeding, strongly indicate the presence of stone in the bladder. But calculus may exist in the absence of some of these symptoms, when it is situated behind the enlarged prostate, and does not approach the sensitive region of the internal meatus. Then the frequency of making water is greater at night in the prostatic affection, but greater during the day when the cause is calculus. A persistent discharge of muco-pus streaked with blood should arouse suspicion. The use of the sound, however, can alone clear up the case satisfactorily.

The existence of non-prostatic tumour of the bladder is less easily affirmed.

FIG. 34.—The exploring Sound, with short beak, for defining tumour, or discovering calculus: here represented in a bladder with enlarged prostate.



Compared with prostatic enlargement, there is more pain in the introduction of instruments, the urine is frequently mingled with sanious discharge and flocculi; examination of which under the microscope may reveal the peculiar structure of villous growth; or may demonstrate that these flocculent matters consist of organised structures possessing significant characters. If an irregular and hardened mass is felt in the rectum, malignant tumour is almost certainly present.

Simple uncomplicated chronic cystitis, with catarrh, is by no means common: this condition being almost invariably due to the presence of a foreign body, to some form of obstruction, or to paralysis, or atony, depriving the patient of the power of expelling the contents of his bladder. We may assume that in most obscure cases there is a material cause, frequently calculus, the presence of which needs a searching examination to verify.

Acts of voluntary over-retention of urine are sometimes followed by atony of the muscular walls of the bladder, and a state of chronic retention follows from their consequent inability to expel the vesical contents. The resulting condition resembles the retention produced by enlarged prostate, and requires frequent relief by the catheter in the same way, at least for a time. Here the absence of physical signs, the existence of a cause recognised by the patient, and the diminished power of discharging urine after a catheter has been placed in the bladder, especially when he is recumbent, are sufficient to distinguish this affection. In enlarged prostate, the urine often flows with force when the influence of obstruction is removed by the introduction of a catheter, and the current can be accelerated by the will of the patient, unless there be atony also, as there may be from undue distension. But when the cause of retained urine is not obstruction, but atony of the bladder, the urine barely flows from the catheter, and is not propelled by any efforts of the patient.

Lastly, there is paralysis of the bladder; a condition in which its nervous supply is either impaired or destroyed: and almost always associated with paralysis of the lower extremities, resulting either from disease or injury of the brain or spinal cord. There can be, therefore, little doubt respecting its presence; and the indication which catheterism presents is characteristic. An instrument being introduced, the urine is propelled by the weight of the parts around, the will of the patient exerting no influence upon its flow unless the abdominal muscles are in a normal condition, as in cases of injury (rare) occurring to the spinal cord between the sources of nervous supply to those muscles and to the bladder, in which case a slight influence is perceptible. Otherwise no impulse is noticeable, except through the agency of such acts as deep inspiration, coughing, sneezing, and the like, by which a momentary pressure is communicated to the paralysed bladder, and the stream temporarily accelerated.

Treatment may be regarded under three heads:—

1. Treatment to obviate the results of obstruction caused by hypertrophied prostate.

The fact being known that urine is habitually retained in the bladder, however forcibly efforts to evacuate it have been made, the first thing is to draw off the urine at least once a day. It may be desirable to do so two, three, or more times, daily, the necessity depending on the amount of residual urine. And if the power of urinating is quite lost, the catheter must be used as often as a decided want to micturate is felt. Certain modifying circumstances must be taken into account; such as the facilities which exist for passing instruments, and the condition of the urethra. If the patient is able to pass a catheter easily for himself—and it is very rare that he cannot do so by tuition and practice—he complies with the demands of his case. He will soon discover that, having his own sensations to guide him, he can easily manage an instrument in his own urethra. But if this be extremely irritable, and is aggravated by frequent use of the catheter, it is necessary to consider the relative necessities of the urethra and the bladder, and some compromise must be made between them. In many cases, the removal of the urine night and morning suffices to maintain the bladder in a healthy condition, and it is undesirable to use a catheter more frequently than is necessary to ensure this. For the use of the patient

himself, and generally for the surgeon, flexible instruments are, in the great majority of cases, the better and safer kind. When silver instruments are necessary, the curves require to be larger than those ordinarily employed : three forms are shown in the annexed woodcut. The fourth catheter is an English gum, mounted on a well-curved stylet to ensure when unmounted a proper form.

When the necessity for a catheter is very frequent, some have advocated the plan of permitting a catheter to remain in the bladder for days together ; but this is not desirable, since irritation and even ulceration may be soon produced by the instrument. Where great frequency in making water exists, and ease and sleep are promoted by the plan, it may be adopted for twelve hours or so at a time ; as during the night. But in circumstances of retention, which has been relieved with difficulty by the catheter, we may permit it to remain for a considerable period. The vulcanised india-rubber catheter is the easiest for the patient, and the least liable to be encrusted with phosphates when tied in. It may sometimes be introduced without a stylet, but owing to its extreme flexibility often requires to be mounted on one, which is then withdrawn and the tube left in place. Usually it is easy to retain it there by passing a piece of soft string or bobbin round the penis behind the glans, attached to the neck of the catheter. If there is a tendency to slip out, it is usually quite overcome by applying a piece of soft adhesive plaster round the whole of the penis, and so covering the retaining string.

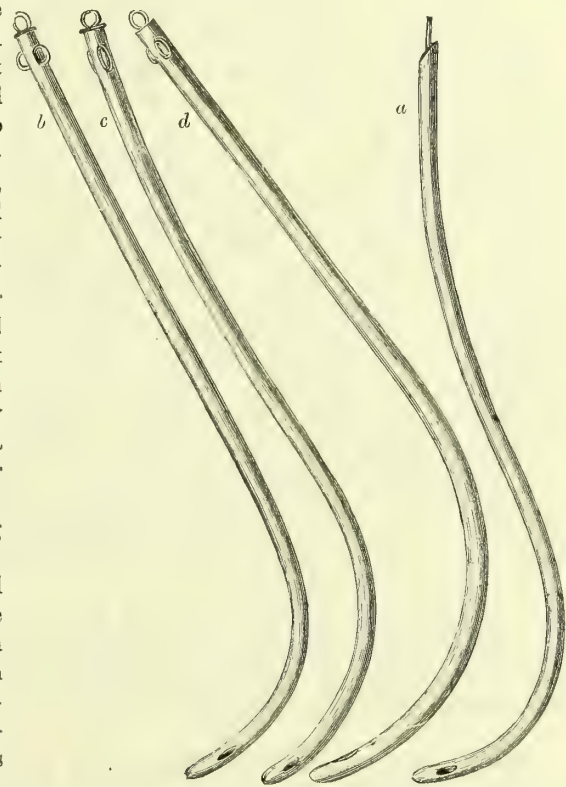
The consequences of enlarged prostate thus described at some length, viz. increasing retention of urine and habitual distension of the bladder, from the completely emptying it daily, constitute a state of very serious danger for most persons so affected. It is impossible to overrate the benefits arising to these patients from the habitual use of the catheter ; and the responsibility which is incurred by overlooking it should be ever present to the surgeon's mind in dealing with any signs of irritability of bladder, or incompetence to retain perfectly the urine by patients in advanced years.

For the treatment of chronic cystitis, catarrh, &c., often arising from hypertrophied prostate, see sections thus headed, pp. 183-4.

2. The general treatment of enlarged prostate.

It is important to maintain all the functions of the body in healthy action, since slight derangements in other parts of the system augment the urinary symptoms. A simple catarrh, a fit of indigestion, or unrelieved constipation, are apt to produce increased obstruction or greater irritability of the bladder. All therefore that deranges the stomach and bowels, and taxes unduly the digestive powers, must be avoided. The clothing and the habits should encourage a due action of the skin : damp must be avoided : the lower limbs should be kept habitually dry and warm ; as freedom of circulation here is a safeguard against congestion in the organ. Lastly, the patient must be encouraged to exert his physical powers, as far as they exist, in daily

FIG. 35.



exercise in the open air, of which walking is the best form. Riding is generally out of the question; or long drives over rough roads; or, indeed, any prolonged travel is liable to arouse local symptoms.

3. Special treatment of the hypertrophy itself.

Although many agents have been employed, all medical treatment has been hitherto destitute of any power to reduce the size of the enlarged organ. Hemlock, mercury, hydrochlorate of ammonia and iodine have all been largely tried, and a certain utility has been claimed for them; but it must be confessed that there is no ground to consider them efficacious against senile hypertrophy.

The influence of compression in retarding the progress of morbid enlargements has been long recognised; attempts have therefore been made to extend its influence to the prostate. Physick, the American surgeon, first, afterwards Leroy d'Etiolles, Mercier, and others, have invented various appliances for effecting this purpose. Dilatation by water in expanding india-rubber tubes was formerly tried by myself. I cannot say, however, that any benefit is to be anticipated by any of these means.

Division of the obstructing portion at the neck of the bladder has been performed. Other operations have been also attempted for effecting a similar purpose, such as the excision or the crushing of a protruding portion; and even the ligaturing of a polypoid outgrowth. Respecting the division of an obstruction, bar-like in its form, elevated from the posterior border of the neck of the bladder, it is no doubt a proceeding to be accomplished without much difficulty, with the exercise of ordinary care. In most cases, although not invariably, the bar is a prostatic development, and when well marked may perhaps, in some cases, be incised with advantage, and without danger to the patient. Such was the opinion of the late Mr. Guthrie. Mercier of Paris advocated the same proceeding some forty years ago; but notwithstanding his reported successes, no confidence in the treatment was ever manifested in Paris, and no surgeon of repute ever performs the operation now. Prof. Bottini of Pavia asserts that he has achieved similar success by dividing the obstruction with a heated galvanic wire, and so avoids the hæmorrhage liable to occur after any adequate incision by the knife. I cannot say, however, that I have yet seen a case in which it has appeared at all advisable to practise any of these operations. So much can be done by maintaining the bladder in a healthy condition by means of the catheter, that the case must be rare indeed in which such an operative procedure is indicated.

In estimating these proposals, most English surgeons will be content with awaiting further experiences in the hands of those who have hitherto seen fit to adopt them. We can cherish little hope that any benefit will be conferred on the patient by such methods, even granting the possibility of carrying them into execution.

Atrophy of the prostate.—The prostate is sometimes atrophied in old age, and occasionally it is so under certain circumstances in early adult life. It is but slightly developed in some malformations, and in constitutions in which the male sexual character is not strongly marked. The normal weight being about four and a half drachms, it is occasionally found as low as two and a quarter, and not infrequently at three drachms, at ages between sixty and eighty years. There are no special symptoms of atrophied prostate, nor is any special treatment indicated for patients who are the subjects of it.

Malignant disease of the prostate is a rare affection; although a few cases are perhaps overlooked among the large number assigned to senile hypertrophy; while it is impossible, with ordinary care, to confound it with the last-named affection.

It is almost invariably encephaloid; but very rarely indeed, in two cases only within my knowledge, true scirrhus is met with in the prostate.

Malignant disease has at present been observed only in childhood and at advancing age: there are no cases on record between the ages of eight and forty-one. The duration of the disease, from the first symptoms to the fatal result, varies from one and a half to five years in adults, and from three to nine months in children.

The symptoms are those common to prostatic obstruction of any form, but

occurring with greater rapidity than in senile hypertrophy. Besides them, there are others, such as more severe pain, often very intense; occasional, often frequent, hæmorrhages; and more or less constitutional cachexia. The pain is felt in the rectum, in the sacral region, and shooting down the thighs.

Hæmorrhage is common throughout the disease, sometimes to an alarming extent. The blood is usually voided almost unmixed, frequently after an attempt to urinate which has been attended with greater exertion than usual. Less commonly is the hæmorrhage continuous for some time, as happens in villous tumour, for example.

The enlargement formed by the prostate itself, when examined by the rectum, is hard at first, mostly becoming irregular in outline or consistence. Softening may in the later stages be felt, but the patient's powers do not always sustain him to so late a period as that in which the growth either softens or fungates. Frequently other organs are affected, but by no means invariably. But there are always diseased lymphatic glands adjacent, and sometimes the infection reaches more distant groups. The existence of such swellings in the course of the iliac vessels, or in the inguinal region, may frequently be verified by examination, and is a valuable sign in relation to diagnosis.

The urine should be examined for the presence of cells which may be regarded as malignant from inspection of their forms and constitution. A good deal of débris is seen in advanced cases, and these will sometimes exhibit all the characters of a malignant growth elsewhere. It is not to be forgotten, however, that the urinary passages yield epithelium cells of all forms and sizes abundantly, and these, I suspect, are mistaken sometimes for the so-called 'cancer-cell.'

Regarding the general treatment of malignant disease of the prostate, nothing more can be suggested than applies to the complaint when occurring in any other part of the body. The treatment is palliative, and must be regulated according to the necessities which arise in the progress of the case. Thus, accumulation of urine must be provided against at the smallest possible risk of injuring the part. If catheterism can be dispensed with altogether, so much the better. In no circumstances is it of more importance to be extremely gentle in the manipulation of instruments. The pain must be relieved by opium, and its derivatives administered both by mouth and rectum, better still generally by subcutaneous injection. Hæmorrhage must be treated on principles already illustrated (p. 177). The powers of life are to be supported by every means in our power.

Tubercle.—The prostate is very rarely the seat of tubercular deposit, and when it is so, appears generally to be increased in size, until the later stages of the complaint are reached, when, after suppuration and discharge, its volume may become smaller than natural.

At no period is the prostate affected alone, some other part of the genito-urinary tract being the primary seat of the affection. In most cases the deposit takes place first in the kidney; the organ next commonly affected is the testicle. In fourteen cases collected by myself, tuberculosis of the kidney occurred in eleven, and of the testicle in six; in seven of these cases the lungs are stated to have been diseased, they were probably so in nearly all. It is difficult to name any special symptoms of this affection. Undue frequency and pain in making water, occasionally blood in the urine, and some symptoms of cystitis, are commonly experienced. The presence of pus in the urine, of occasional hæmaturia, of pains in the loins, perinæum, and penis, give rise to suspicions of calculus, to be resolved sometimes only by a careful search; no foreign body being found, the nutrition of the patient, his history, and the condition of the lungs and other viscera, may in time lead to a correct diagnosis.

Nothing need be said of the constitutional treatment of tubercular disease, and little in relation to the local manifestation in the prostate. Mechanical interference is to be avoided, and every kind of irritating application. If suppuration takes the form of external abscess, it must be treated as other perinæal or ischio-rectal abscesses. But more commonly the discharge of purulent and tubercular matter takes place into the urethra. The improvement of the health, by diet, regimen, exercise, climate, &c.,

constitutes almost the whole of the treatment to be employed in the affection, when involving the urinary or genital organs. The diagnosis once established, it is important that the patient should be free from instrumental interference, unless necessary, since it aggravates the disease, without conferring upon him any benefit whatever.

Cysts of the prostate.—It is not at all uncommon, in making sections of an enlarged prostate, to find cavities, of an irregular form, in its substance, not met with in the normal organ. These cavities have all the appearance of being dilated follicles of the glandular structure. Ducts are easily traced into them; and frequently numerous little dark concretions lie free within. I have seen from thirty to fifty of these minute bodies occupying a cavity of one or two minims capacity.

But larger concretions, prostatic calculi, up to the size of a pea, may occupy such cysts, and on removing them a smooth-walled cavity is displayed. Sometimes numerous cavities may be found in one prostate; but this is a rare circumstance. I have in two instances emptied such with a small lithotrite during life.

The formation of these cavities, or cysts as they have been called, depends a good deal on the prior formation of concretions. At all events, the two occurrences are closely associated. Although, in conformity with the practice of other authors, I have referred to 'cystic disease' of the prostate, the use of the term is scarcely warranted by the phenomena presented; and, if retained, it must be held to signify a formation of a wholly different kind from that which is indicated by it in the breast or kidney.

The prostate is, after long-continued suppuration, sometimes converted into a kind of cyst or membranous bag; this condition can in no respect be regarded as a form of cystic disease. The organ has, in fact, disappeared, and its capsule forms part of the sac of an abscess which has replaced the normal structures.

There is no proof that hydatid cysts have ever been met with in the prostate. Cases are on record in which retention of urine and distension of the bladder occurred as a result of a hydatid cyst *between the bladder and rectum*, near to the neck of the former; but in which the prostate was not affected except by pressure. Prostatic enlargement was closely simulated in some of them, and the prostatic catheter was employed under the belief of its existence.

THE MALE URETHRA.

Congenital malformations.

Injuries.

Inflammation.

Stricture of the urethra { organic,
spasmodic,
inflammatory.

Tumours of the urethra.

Urinary abscess, acute and chronic.

Urinary fistulæ.

Retention of urine.

Extravasation of urine.

Rupture of bladder (from retention of urine).

Congenital aberrations and malformations.—1. Absence of the urethra is occasionally met with, as in cases of extroversion of the bladder, in which there is no cavity or reservoir to contain the urine, nor any canal to carry it off; but a mucous membrane, corresponding with the posterior surface of the bladder and with the floor of the urethra, alone remains. See 'Malformations of the Bladder,' p. 180.

2. The canal is sometimes occluded, producing retention of urine, and death during the early hours of life. The obstruction may consist of a membranous diaphragm across the canal, or of an obliteration of some lines in length, and it may occupy any portion of the tract, but is usually found near the vesical orifice.

3. Deficiency of a portion of the urethra near the anterior orifice is the most common deformity; when a part of the upper covering is deficient, the mucous membrane of the floor being exposed, the condition is termed *epispadias*; when the contrary condition is presented, the floor being deficient, the term *hypospadias* is applied to it. The degree of deficiency varies considerably; from a quarter of an inch to an inch and a half may be absent in either case. Occasionally, and this is a variety of hypospadias, there is a second meatus about an inch behind the normal one, opening externally through the floor of the urethra. But the opening may be much further back, and may even render impracticable the ejection of semen into the vagina.

4. Besides these, slight exaggerations in the size or form of the natural parts may be occasionally noted; as of the lacuna magna, the sinus of the bulb, and the sinus of the verumontanum: more frequently there is congenital narrowing of the external meatus, or of some portion of the passage situated within an inch of it.

Treatment.—A simple diaphragm may be perforated when its existence has been clearly ascertained. Congenital narrowing of the external meatus may be dealt with as stricture in that situation. None of the other conditions, with one exception, are improved by the various procedures, by paring and suture, which have from time to time been practised, nor are they sufficiently important to be so treated. But hypospadias, existing so far back as practically to produce impotence, should be remedied if possible by operation. This has been accomplished by a combination of perforating the anterior portion of the penis, paring the edges of the opened urethra, and uniting by suture. Much care and skill, however, are necessary to give the patient any chance of a cure.

Injuries of the urethra.—(See essay on INJURIES OF THE PELVIS, vol. i.)

Inflammation of the urethra.—(See the essay on GONORRHOEA, vol. iii.)

Stricture of the urethra.—The term stricture implies an unnatural contraction of the urethral canal, congenital or acquired. Contraction may occur in two forms: it is the nature of the first to be permanent, and of the second to be transitory only, as regards its duration. A permanent contraction is due to organic deposit in or around the walls of the urethra, and is accordingly termed organic or permanent stricture. A transitory contraction may be regarded as due either to local vascular inflammation or congestion, causing temporary narrowing of some part of the urethra, hence the term inflammatory or congested stricture; or to unwonted muscular action alone, of the voluntary or of the involuntary fibres, in which case it is designated spasmodic stricture. This last-named condition, that of spasm, may exist alone, but is usually found as a complication of the other kinds. The term spasmodic is understood to include only cases in which involuntary contraction of the muscular fibres constitutes the main source of obstruction. So also the term inflammatory stricture can only be employed when the diminished calibre of the urethra is mainly due to an attack of inflammation.

But the terms implying temporary stricture are liable to cause confusion and misapprehension. Obstructed micturition from inflammation has its origin in the prostate, which thus becomes swollen, a condition which cannot be termed *stricture*; just as we have tonsillitis obstructing deglutition, but which is never spoken of as stricture of the throat. Obstructed micturition from spasm of the muscular parietes of the urethra is excessively rare, although spasm may complicate previously existing morbid changes there. Hence I restrict the term stricture to those narrowed conditions of the urethra which depend on organic changes in, and immediately surrounding, its walls—a stricture which is organic and permanent in its nature; and I shall not apply the term to any other condition.

Anatomical classification.—Strictures present themselves in a variety of forms, which may be arranged, although it is by no means important to do so, in four groups.

1. *Linear stricture*; when the urethra is obstructed by a thin membrane stretched across, with an aperture in the centre, or on either side; or a fold of the mucous membrane may obstruct the passage at one of its sides only, forming a crescentic septum, and obstructing a segment of the calibre of the canal; and this has been called 'the bridle stricture.'

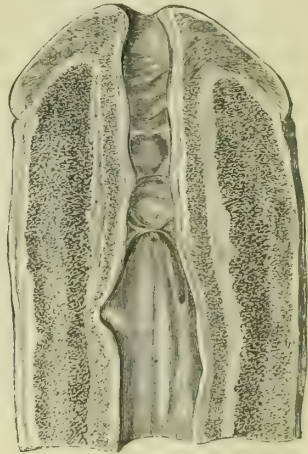
2. *Annular stricture*.—Those instances in which the contracted part is thicker and broader than the foregoing have been termed annular strictures.

3. *Indurated annular stricture*.—This term denotes those cases of confirmed stricture in which the induration is seen to extend deeply into the tissues around the urethra: although it may be limited in extent from before backwards to a space occupying less than half an inch of the canal. The contraction is generally most considerable at the centre of the space, so that the affected portion has somewhat the form of an hour-glass; and the induration is usually thicker at the floor than at the upper aspect of the urethra.

FIG. 36.—Long and indurated Stricture at the junction of the bulbous with the membranous urethra. Much dilatation of the urethra and its lacunæ behind.



FIG. 37.—An irregularly narrowed condition affecting the anterior part of the Urethra, the narrowest point being rather more than two inches from the orifice [drawing half size of nature]. Dilatation of urethra and of lacunæ behind.



4. *Irregular or tortuous strictures*.—In a few instances, some of the natural rugæ of the urethra seem to be adherent, or fused together, for the space of a few lines in length. In rare cases a patch of indurated tissue is seen, around which the mucous membrane is puckered in radiating lines; the amount of contraction appearing to be due to some previous loss of substance. Occasionally the canal is narrowed, and its walls thickened for a length of one or more inches; and the induration sometimes involves the entire substance of the corpus spongiosum, producing the most obstinate and undilatable form of stricture.

Occasionally several separate strictures may be observed in the same subject. John Hunter records an instance in which he met with six strictures in one urethra. Lallemand and other French writers describe seven or eight. My experience is that it is very rare to find the urethra distinctly strictured at more than three or at most four points, testing it with the bulb-ended probe I have always employed. No doubt one may subdivide these chief points of narrowing into subordinate and lesser irregularities, but such refinements are useless for any purpose of practical utility.

Origin, nature, and site of stricture.—The first effect of inflammation upon the mucous membrane is a thickening of it, caused by engorgement of the vessels.

Then exudation of an albuminous fluid takes place into the submucous tissue, and perhaps becomes absorbed under favourable circumstances. But when the morbid action persists, more or less plastic material is thrown out, the result of which is, the formation of fibrous tissue around the canal, causing adhesion between the mucous membrane and the submucous tissue, infiltrating the meshes of the latter, and even involving the substance of the corpus spongiosum itself.

A widely-differing condition is referred to by some as a source of stricture: namely, an exudation-deposit upon the surface of the mucous membrane occasioning occlusion of the canal. Few cases are on record, or are to be found in our museums; and it is quite certain that this condition is extremely rare

It has generally been held that the degree of contraction is proportioned to the duration and extent of the inflammatory action which has pre-existed; although the severity of the symptoms are by no means commensurate with the amount of narrowing which exists. It is very rare to find any urethra altogether impervious during life to the flow of urine. However contracted the canal may be, the urine still issues either in a very small stream or by drops. Retention does not depend on absolute organic impermeability. It is easy to conceive that when the canal is contracted to a mere pin-hole, the slightest cause may produce complete retention; a little tumefaction, thick mucus, or a small calculus suffice to block up the channel. Probably the sides of the urethra never adhere, and cause obliteration of the canal; unless fistulæ have been established, when, although very rarely, adhesion may take place anterior to the stricture; but only in cases of traumatic origin. The urethra may be cut across by a wound in the perinæum, and for want of proper attention the urine may pass entirely through the artificial opening, and the proper passage become closed. But such obliteration is a wholly different thing from stricture, and is not to be confounded with it.

Locality of stricture.—After a laborious examination of 270 preparations in our principal museums, I have arrived at the following results. All examples may be arranged in three distinct classes:—

1. *Strictures occurring near to the junction between the spongy and membranous portions of the urethra*; a region comprising an inch of the canal before, and three-quarters of an inch behind, that point, thus including the membranous portion. The most frequently affected part is the bulbous part of the spongy portion. The liability of this part to stricture appears to diminish as it approaches the deep fascia, behind which stricture is very rare.

2. *Stricture in the centre of the spongy portion*—i.e. a region extending from the anterior limit of the preceding to within two inches and a half of the external meatus, and measuring therefore about two and a half to three inches in length.

3. *Stricture at or near the external orifice.*

The following is an analysis of the 270 preparations referred to; they exhibit 320 distinct strictures:—

Total number of strictures, 320:

„	in region 1	. . .	215, or 67 per cent. of the entire number.
„	„ 2	. . .	51 „ 16 „ „ „
„	„ 3	. . .	54 „ 17 „ „ „
			320

Of these

There were 185 examples of *one stricture only*, situated in region 1.

„	17	„	„	„	2.
„	24	„	„	„	3.

There were 8 cases in which the urethra was strictured in all three regions.

„	10	„	„	„	in regions 1 and 2 only.
„	10	„	„	„	1 „ 3 „
„	13	„	„	„	2 „ 3 „

Respecting so-called ‘prostatic stricture,’ it may suffice to state that there is not a single case of it to be found in any public museum in London, Edinburgh, or Paris. nor have I ever met with an example. It must be concluded that it owes its supposed

existence to inferences drawn from the results of examination on the living body, which can by no means be admitted as evidence on this subject.

Causes of organic stricture.—There are two principal and distinct species of lesion which give rise to the formation of stricture of urethra. The first, and the most frequent, is inflammation of the canal; the second is injury by violence.

Fortunately the inflammation, in the great majority of cases, terminates by resolution, and leaves the urethra as healthy as before; and this is true, whether the urethritis be gonorrhœal, or of non-sexual origin. But in exceptional cases, occurring in some instances perhaps from the patient's indiscretion, in others from violent treatment, and in others from a constitutional disposition, the inflammatory action produces the deposit which ends in stricture as before described. This last-named cause is not a speculative theory, for I am now quite satisfied that in certain families individuals inherit a proclivity to the formation of stricture. And thus it is that one person may have numerous attacks, which are obstinate and subjected to treatment of all kinds, for long periods of time, yet never have the slightest stricture afterwards; while others, after one brief attack, may have stricture ever after. Again, in some cases it seems to be the persistence of chronic inflammation which lays the foundation of organic stricture. Hence a long period often elapses between the acute attack and the first symptoms of obstruction. These latter appear often very insidiously and slowly, and at first perhaps scarcely excite the attention of the patient. Thus it is that a period of many years is often passed before the existence of the organic change has become obvious.

The next principal cause of stricture is mechanical injury. Blows on the perinæum, bruising, lacerating, or partially destroying the urethra; as by severe falls across spars, scaffolding, ladders, chairs, gates, wheels, saddles, laceration from the bones in pelvic fracture, &c. A wounded urethra often unites irregularly, or loss of substance takes place, and the cicatrix resulting permanently contracts the part. Such strictures are among the most obstinate and difficult to deal with.

An occasional cause is cicatrization following chancre or other ulcers at the external meatus. After amputation of the penis, the orifice is also sometimes narrowed in a similar manner.

Narrowing within half an inch or an inch of the external meatus is an occasional congenital formation, and it may exist up to adult age without occasioning inconvenience, or being discovered, and yet become the source of severe symptoms. The tissue appears to become in later life less extensible, and may then interpose a serious obstruction to the outflow of urine.

Symptoms.—Slight urethral discharge is often an early symptom. Pain is usually felt in the urethra, behind the stricture, at the time of micturition. The bladder acts more frequently than natural: the stream becomes flattened, twisted, or divided—conditions caused by the current being insufficient in force to extend the lips of the meatus externus; but it must not be concluded that such a stream is a proof that stricture exists, since many persons, from a tumid condition of the meatus alone, habitually pass such a one. As contraction increases the stream grows smaller, or the urine may issue only by drops; while the act of micturition is prolonged to a corresponding extent. Ultimately patients are compelled to rise from bed many times in the course of the night; while in the worst cases, or during temporary exacerbations, much time is spent in unavailing efforts, by change of posture or by straining, to obtain relief. In bad cases the patient can rarely attempt to empty his bladder without visiting the water-closet, through his inability to control the rectum, and from the troublesome prolapsus often occasioned by repeated powerful muscular action. Pains in the perinæum, the testicles, the loins, and the hypogastric region are usually present in such cases.

In a few cases the most prominent symptom throughout is retention. There may be but little irritability of bladder, and the stream of urine, when passed, is not always very small; a No. 6 or 7 catheter may pass through the urethra; but the patient is liable to frequent retention requiring catheterism, while attempts at dilatation only increase inability to pass water.

In advanced cases the urine, being retained in the bladder, becomes cloudy, ammoniacal, and charged with pus and mucus. Sometimes a little blood is passed also; it frequently follows the use of the catheter, but appears also when no instrumental interference has taken place. Sometimes the urine passes involuntarily during sleep, or during muscular exertions; and a so-called 'incontinence' is often said to occur. It infects the patient with a urinous odour, and, despite all precautions, excoriates the skin, and renders him offensive to himself and others. But these symptoms, in nine cases out of ten, indicate that the bladder is distended, and that the surplus only runs off in the manner described, the organ remaining filled with the staler portion of the urine, unless it be emptied by the catheter. Thus it is a state of retention, or of engorgement, and not of incontinence. Under these circumstances disease of the bladder is increased; and ulceration may occur in its mucous membrane, or in that of the urethra behind the stricture. In this condition, during a paroxysm of straining to pass water, rupture of the urethra may take place, and extravasation of urine occur into the cellular interspaces in the perinæum, scrotum, and supra-pubic region (see 'Extravasation of Urine').

Besides the local symptoms of stricture, there is usually disorder of the digestive organs, followed by the consequences of impaired nutritive function. The patient loses flesh and strength, and often becomes the subject of severe attacks of shivering. Some invariably experience rigors after the passage of a bougie, or if an instrument but one number larger than the accustomed size be passed. So well known is this phenomenon that it has received the special name, and not inappropriately, of 'urethral fever.' It often occurs after the first act of micturition following the application of the instrument, as if from contact of urine with an abraded urethra, or with the wound if incisions have been made. When chronic pyelitis or renal disease exists, these symptoms are more prone to occur and to be intermittent, so that we may suspect the presence of such disease when severe rigors constantly follow slight urethral irritation in patients not predisposed by climate to experience them, and who have suffered for some time from stricture. I have observed, on more than one occasion, suppression of urine, rapidly followed by death, to result from the introduction of an instrument larger than the patient has been accustomed to; or again, when the ordinary instrument has been less skilfully employed, and an abrasion, although only an exceedingly slight one, has been made in the mucous membrane of the urethra. The rapidity with which death may occur, under these circumstances, in patients who are the subjects of extensive chronic disease of the kidneys, from an apparently trifling lesion so caused, is remarkable. It seems to be due to blood-poisoning, often uræmic; the autopsy does not necessarily reveal traces of inflammation resulting from the particular lesion. In these cases it appears that the function which determines the elimination of urea suddenly ceases after slight injury to the urethra, as by the propagation of some shock to the excreting organ, in cases where the kidneys are largely diseased. And there are undoubtedly sometimes, although rarely, instances in which the fatal result ensues from the mere passing of a catheter, although it is absolutely certain that no mechanical injury whatever has been inflicted.

Founded on the symptoms, three classes of organic stricture may be made, for the purpose of describing in brief terms any particular example:—

1. *Simple stricture*.—Its chief sign is diminution in the size of the stream; with increased frequency of micturition and some pain, although the amount of either varies greatly in different cases.

2. *Sensitive or irritable stricture*.—Proneness to disturbance of the nervous system, as evidenced by chilliness, irregular circulation, or even rigors on slight irritation. Much pain is caused even by the gentle application of instruments, and sometimes also a disposition to hæmorrhage is manifested.

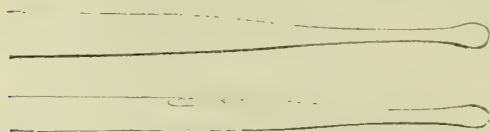
3. *Contractile or recurring stricture*.—There is a strong tendency to become narrower in the absence of treatment; and contraction rapidly recurs after dilatation has been applied, which often aggravates rather than relieves the condition of the patient.

Exploration.—The symptoms just detailed are not sufficient alone to establish the presence of stricture: it is necessary to examine the urethra with an instrument to ascertain whether an organic obstruction exists, whether one or more are present, their calibre, and what extent of the canal is involved.

Instruments.—Before considering the subject of diagnosis proper, it will be desirable first to take a general view of instruments employed in the urethra, and the methods of passing them. They are made of various forms and compositions: some are soft and pliable, others are elastic, others inflexible and solid. Some are solid throughout, mostly called bougies; others are hollow, to permit urine to flow through, and are termed catheters. Catheters may be made of silver, or of flexible and elastic materials, each variety being valuable in different circumstances. As a rule, the flexible instruments, whether hollow or solid, are less irritating to the urethra than the inflexible, and I advise their employment in most cases. They are of two kinds, and made in two forms. The English gum-catheter has a considerable amount of firmness when cold, but is very flexible if placed in water 110° Fahr., and will retain when plunged into cold water almost any form communicated when warm. This quality is of extreme value, especially in the treatment of enlarged prostate where a well-curved instrument is required. Ordinarily they are mounted on curved stylets, which maintain the desired form, but the stylet, as a rule, is to be withdrawn from the catheter before using it. Bougies of the same material are susceptible of similar treatment. Formerly they were made of wax—hence the name—but they have fallen into disuse, being replaced by better materials.

The French instruments are much softer and more flexible than the English, and may be made either curved or straight, not taking any other form than the original one. But their extreme flexibility enables them often to traverse the urethra without pain or even discomfort to the patient, often when inflexible instruments pass with difficulty. Perhaps, as a rule, no instrument passes either in a healthy or in a strictured urethra, provided the obstruction is not exceedingly narrow and tight, so easily as the French bougie, which tapers for one-third of its length towards the end,

FIG. 38.—Bulb-ended Bougie and Catheter.



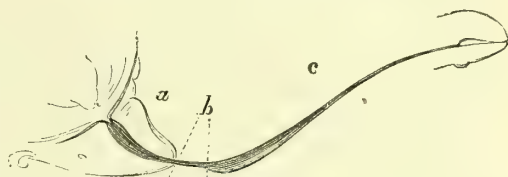
this consisting of a bulb half the size of the full calibre of the instrument (see fig. 38). The long and flexible extremity winds through the passage; and were the instrument to end in a point, this might readily be caught in some lacuna; but the

terminal bulb prevents this, and the merest tyro can generally pass it at once into the bladder. In doing so, if the patient stands, the bougie, being oiled, is merely introduced and pushed horizontally inwards, without any attempt to direct its progress. The bulb-ended bougies and catheters, usually termed 'olivary bougies,' are often of extreme utility both to the surgeon and to the patient who requires them for his own use, but they are unsuitable to tropical climates, where for the most part metallic instruments are necessary.

To introduce the silver catheter, and supposing the patient to occupy the standing position, the following plan may be adopted. Let the handle or upper end of the instrument be lightly held between the thumb and the fore and middle fingers of the right hand, the concavity of the curve looking towards the left groin of the patient. The penis is to be raised with the left hand, the point of the instrument inserted into the urethra and slowly carried onwards until four or five inches have disappeared; the handle is brought vertically to the middle line at the same time, close to the patient's abdomen, after which it is to be gently and lightly depressed; and as the point is felt to traverse the sub-pubic curve, the handle is gradually brought down towards the operator, until it sinks beneath the horizontal line, when the opposite extremity will be free in the bladder. If difficulty occurs, the direction of the instrument may be slightly altered, or it may be withdrawn an inch or so, and then re-introduced with the handle more upright than before, or the reverse, as the case may require. If, notwithstanding all, the instrument is stopped point blank, and at

the same spot on each trial, obstruction may be suspected. On the other hand, if the urethra is healthy, a solid sound of good size will pass almost by its own weight if lightly handled; at all events, a very slight pressure from the forefinger upon its handle will be amply sufficient, if additional impetus be required. The main point is to allow the point to slide easily along the *upper* surface of the urethra. It will not then be caught in the depression of the bulb on the floor of the urethra, nor will it be so likely to be impeded in the sinus of the prostate. (See the annexed diagram representing a section of the urethra throughout its course.) It is never to be forgotten that, if obstruction is encountered, it is never to be forced: temper, patience, and a light hand will overcome almost all cases of difficulty. All attempts at rapidity of execution are wholly out of place, fraught only with danger to the patient, and calculated to reflect discredit on the operator.

FIG. 39.—Section of the Urethra.



a, prostatic; b, membranous; c, spongy portion.

That mode of passing a catheter which has obtained the name of the '*tour de maître*' can be only necessary with an extremely corpulent patient. It consists in introducing the instrument with the convexity of its curve upwards, and with the handle in a perpendicular line beneath pointing to the floor; in carrying it to the deep perinaeal fascia in this direction, and, when it has arrived at that point, in sweeping it round upwards so as to describe a half circle, of which its point is the centre; and then gradually depressing the handle to carry the instrument through the sub-pubic curve.

When much time is required, the patient should be in a recumbent position; the head and shoulders slightly elevated, the knees a little raised and separated from each other. The operator should stand on the left side, hold the catheter as before directed, and introduce it over the left groin, the handle being horizontal; he should support the penis with the left hand, introducing the beak of the instrument at first against the inferior wall of the canal, to avoid the lacuna magna on the roof. The fingers of the left hand gently draw the penis over the instrument as it glides easily on to the bulbous part, the handle still being horizontal, or nearly so; arrived at which, if some obstruction seems to offer, the instrument should be withdrawn an inch or so, and again passed, taking care not to elevate the handle so soon; after which, by gently raising it and causing it to describe a curve along the middle line, the extremity should glide upwards into the bladder as the handle sinks towards the interval between the patient's thighs. In passing an English gum-catheter, it should be well curved after the stylet is removed, as the warmth of the urethra tends to straighten the instrument, and so occasion it to hitch on the floor on arriving at the membranous portion. The point should be well turned up, and the curve maintained in passing the first half of the catheter very close to the belly of the patient, after which a rather quick depression of the shaft carries the point easily into the bladder.

Diagnosis.—In exploring the urethra, we are not hastily to conclude, because a little obstruction presents itself in the passage, that stricture is of necessity present. The part is extremely sensitive, and resists any but gentle efforts to traverse it, the more so if it be the first time an instrument has been introduced. Sometimes at the neck of the bladder itself a little more than usual depression of the handle of the catheter is required, or it may be necessary to employ an instrument with a stronger and longer curve.

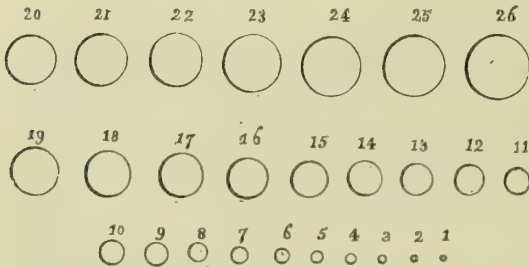
The size of an instrument to be first used is by no means a matter of indifference. As a rule, whatever statements the patient may make, we should always use a bougie or catheter not smaller than No. 8 to 10, with a blunt, not conical or bulbous, extremity, as the former affords more certain indications of the situation of obstruction than a small instrument, which might pass through a slight constriction altogether; while a taper point may be entangled in a lacuna, or in a fold of mucous

membrane, the first of which would have been closed, and the second obliterated, by the passage of an instrument sufficiently large and blunt to distend a little the urethra. By such entanglement, perhaps, injury may be inflicted on the canal, or the unfounded belief in the existence of a stricture may be induced.

Suppose, however, that a real obstruction is encountered, its distance from the external meatus should be accurately noted. Then a smaller instrument is to be passed, to determine the calibre of the stricture; the existence of which is manifest by the instrument being '*held*'—*i.e.* it has entered a narrower passage which fits closely to and retains it, so that on attempting to withdraw, some force is necessary for the purpose. A trial of several instruments may be necessary, until one sufficiently small to enter the constriction is arrived at; but we are to bear in mind that the smaller the instrument the more careful must be the operator and the more sparing of pressure, since such an instrument will inflict a wound with ease directly proportioned to the smallness of the point.

The method just recommended suffices simply to determine the existence of stricture under ordinary circumstances. When it is desirable, as it often is, to have an exact knowledge of the length to which the canal is affected by narrowing, a bulbous-ended instrument, of which the shaft is slender, is to be employed for the purpose. For this purpose several must be used with bulbs of various sizes, from about No. 2 to No. 12, the stems of the smaller bulb to be equal to that of a No. 1 catheter, and of the larger about No. 3 or 4. One of these is found, after trying several, the bulb of which passes with slight pressure through the stricture, when it is felt

FIG. 40.



to be free and easily movable beyond; and on withdrawing it, the bulb again recognises, in returning, the obstruction at first encountered. In this manner, the extent of contracted urethra, generally comprised within a range of the fourth or half of an inch, is readily estimated. So also the existence of other strictures beyond the first are to be demonstrated in the same way.

Various attempts have been made to examine the urethra and bladder. The object of this is to introduce a straight metal tube, by means of an instrument called the '*Endoscope*,' between 9 or 12 of the catheter scale, into the urethra, and one in the form of a beaked sound, with a glass at the angle, into the bladder. To the tube when introduced a lamp is adjusted, with eye-piece and reflector, so as to throw a pencil of light on whatever impinges directly on the bottom of the tube, an area comprised within a circle of about the fifth of an inch in diameter. The same tube may be employed also with an ordinary jet of gas, or with sunlight. Many improvements have been made on this apparatus, the latest being a very complicated and ingenious machine, elaborated with great care and skill by Leitner, the instrument maker of Vienna, by which he safely introduces a wire, heated almost to whiteness by the galvanic current, into the cavity it is desired to illuminate, in this case urethra or bladder. Although this arrangement is by far the most powerful and efficient that exists, I am compelled to say, after practically testing its capacity on many cases, that endoscopy is of very little value in stricture, or in other complaints of the urinary organs. It is easy to see the colour of the mucous membrane of the urethra and of the bladder near the end of the tube; also to see the portion of a calculus against which the tube rests. The employment of such an apparatus, moreover, is not to be regarded by any means as a painless proceeding, to say the least of it; commonly it is productive of much irritation. With a large tube suited for examining the rectum, the result is very much more satisfactory.

Hitherto, in speaking of the sizes of urethral instruments, the English scale has been always assumed, as being that best known in this country. The scale, however,

of the French is better, as producing smaller intervals between each number, in making these intervals more regular, and the number itself to express the measure of the calibre marked by each instrument. No. 1 is one millimetre in circumference, No. 2 is two millimetres, and so on up to 30. The Nos. 3 to 21 represent pretty generally the Nos. 1 to 12 of our scale—that is, about 18 numbers instead of 12. A facsimile of the metrical scale is seen at fig. 40.

Treatment.—Its object is twofold :

First, to restore the natural calibre of the canal, so far as is consistent with the safety and comfort of the patient.

Secondly, to maintain the adequate patency of the canal afterwards.

Now, since strictures vary in contractility, in dilatability, in disposition to return, in sensibility, and in liability to excite constitutional disturbance, various modes of treatment are employed for different cases. Hence numerous inventions for fulfilling the above indications have been proposed. All, however, may be resolved into three classes. The tissue of the stricture is either dilated, gently or forcibly; or it is acted on by chemical agents; or it is divided by some cutting instrument; and of course all these processes are combined with constitutional treatment.

Dilatation.—This is the mildest and most desirable treatment whenever the case is amenable; it is the most generally applicable to a large proportion of the cases met with. It is the method which most surgeons agree to use as the rule, availing themselves of other means when its action after fair trial is found to be inefficient. The history of surgery shows that it is still the most ancient mode, having been employed for the destruction of ‘carnosities’ in the time of Galen, and never having been superseded to the present day.

To apply it in ordinary cases, a flexible olivary bougie, as large as the stricture will easily admit, should be passed fairly through it, and then be at once withdrawn; a note of the size should be recorded; two or three days after the same may be passed with greater ease than before, and the next size larger introduced, perhaps another if no undue force is required. The process is repeated as before, if all goes well, until a full size is reached. Sometimes, however, a fit of shivering follows; if so, the interval should be lengthened a day or two, and the condition of the health examined. If the patient complains that micturition is painful, it will be desirable to regulate his diet and habits so as to promote a healthy character in the secretions generally. At the same time, he may derive benefit from a little potash, combined or not with hyoscyamus, and taken three or four times a day; or, with infusion of buchu, if the bladder is irritable, or the urine cloudy. Irritability of the urethra, however, is allayed by the gentle and careful use of instruments; and when pain is produced at the first attempt, it usually becomes less as we progress. Supposing dilatation to have reached No. 11 or 12, or, if it proceeds easily, No. 13 or 14, or more, the maximum degree should be maintained for a short time, the largest instrument being used at gradually increasing intervals of time, and the patient taught to use it thus himself.

If, however, the case is at the outset difficult, and after the use of a small instrument no penetration is effected, it is necessary to see the patient make water; if the stream is small, the size of the instrument should correspond with it; if it is not, the contraction cannot be very considerable, and some fold of membrane, or perhaps a false passage, has entangled the point; and in any case the bougie to be tried next should be as nearly as possible of the size of the stream. In introducing it, the floor of the urethra is to be avoided, this being a favourite situation for false passages. Failing of success in one direction, we should next cautiously vary the direction of the point, trying patiently to insinuate it either above, below, or on either side of the passage, if the slightest sensation of its being ‘held’ indicates that the orifice exists in any of these directions. And when the instrument has thus become a little grasped, we should endeavour to facilitate its progress by patient, continued, and moderate pressure, the precise amount of which should be proportioned to the degree which the patient will bear without much complaining. Some minutes should be devoted to the attempt, the success of which will much

depend upon the steadiness and singleness of purpose with which it is pursued. Sometimes the introduction of the left forefinger, previously oiled, into the rectum, will facilitate the progress of the instrument, either by permitting its point to be raised to some extent, or by enabling us to judge more precisely of its exact locality and relation to the parts around; above all, whether it is or not in a false passage.

The employment of continued pressure on the face or commencement of an indurated and not very sensitive stricture is sometimes successful. The operator, however, should be certain that he is really acting on the contraction, and not following or making a false passage. It is important to remember, in relation to these attempts, that when the instrument is tightly grasped, the operator may generally infer that its point is within the strictured part, and that when the point feels free, movable, and capable of being withdrawn without appreciable effort, it is certainly not in the stricture; it may be, in such circumstances, in a false passage. If, after being grasped or 'held,' it advances suddenly for a short distance under pressure, and becomes movable, it is probable that a false passage has been made and the urethral walls perforated; after which further efforts must be given up, at least for some days, and the employment of instruments, when again resorted to, must be conducted with vigilant care, to avoid any re-opening of the lacerated part.

If after several trials the stricture is still not passed, it will be well to make the next attempt when the patient is in bed, with the skin warm and perhaps just after a hot hip-bath. Premising that the situation of the stricture has been already verified, a silver catheter should be selected, the size of which should be a little less than that of the stream of urine. It seems useful sometimes to apply oil *to the urethra itself*, rather than to the instrument, injecting through a common glass syringe four or five drachms; which tends to open the narrowed passage by the penetrating action of the oil.

When the stricture has been passed, care is necessary in guiding the instrument through the canal beyond to prevent the point becoming engaged in the lacunæ commonly found there. Usually it has to be tilted upwards somewhat; and here it is that the finger in the rectum is most commonly of use.

False passages present one of the most perplexing complications of stricture, inasmuch as the difficulty of finding the right opening is greatly increased by the readiness with which the instrument enters the wrong one. It is to be remembered that, as a rule, false passages most frequently commence on a level below that of the proper opening; and that the operator's finger, when in the rectum, near to which the false passage is almost certain to run, will inform him as to the route which the catheter is taking, whether it be too close to the gut or deviating to the right or left of the median line, and will also assist him to direct the point in its true course.

The influence of chloroform or ether has been found useful in facilitating the passage of an instrument, especially when the parts are sensitive and give rise to uncontrollable and involuntary efforts of resistance on the part of the patient. Anæsthesia is not for the purpose of permitting the instrument to be used with greater force, but to produce insensibility to pain and relaxation of the muscles, and the agent must, of course, be given to a sufficient extent to insure this result.

Continuous or permanent dilatation.—A useful means of rapidly dilating a stricture which has been obstinate under ordinary treatment is that of retaining the catheter in the urethra for forty-eight or seventy-two hours at a time, without removing it. Especially when great difficulty has been encountered in its introduction, this treatment is frequently of great value; if, owing to extreme sensibility, each introduction of an instrument is followed by much pain or by rigors, it is sometimes one of the most efficient methods which can be adopted. In putting it into execution, a week or two of confinement to the house must be reckoned on. The catheter having been introduced, it may be fastened by bandages round the body, or better, to the pubic hair, and a little plug is fitted to the orifice of the catheter, or a piece of india-rubber tubing attached, with the other end in a suitable vessel. There are three points to be attended to: First, the catheter when tied-in should not project into the bladder, or at any rate but very slightly; the proper

distance is readily ascertained by observing the flow of urine through it, and drawing the instrument outwards until the stream just ceases; and fastening it in that situation. Secondly, if the first catheter passed has been a silver one, the succeeding instrument should be flexible, as causing less irritation, indeed rarely any, while the process of dilatation is quite as efficient as when metal catheters are employed. Thirdly, in no case should an instrument be permitted to remain in the urethra which fits tightly in the stricture; more dilatation is achieved by always using a catheter which lies loosely in the canal than one large enough to be grasped by the contracted portion, since the latter causes irritation which may produce unpleasant consequences. During the period of remaining in bed the patient is rarely much inconvenienced if these points are attended to. If, however, he has much fever or bloody urine, or an attack of orchitis, it may be prudent to withdraw the catheter.

Usually, in about thirty-six hours, a purulent discharge appears, and the instrument soon becomes loose in the canal, although when first introduced it may have been firmly retained by the stricture. It may then be replaced by another two sizes larger, and in another day or two a similar advance may be made; the patient sitting up daily for a few hours, if the gum-catheter is employed. When a full size has been reached, the catheter is to be withdrawn, and an instrument passed daily for a few days, gradually increasing the interval, but endeavouring to retain as much as possible of the calibre gained; a certain degree of recontraction at first, however, is always met with.

Mechanical apparatus for effecting dilatation.—Among various forms of special apparatus may be noticed the method by sliding tubes over a small urethral guide first passed into the bladder; so that if the route is at first correctly taken, all the other tubes will follow the same course. It is difficult to say when this principle was first adopted, but certainly at an early date. Thus Desault advocated it (1797), more recently Dr. Buchanan of Glasgow (1831), Dr. Hutton of Dublin (1835); and Maisonneuve (1845). Mr. Wakley formerly improved and systematised the method; but none of these plans have come into favour with surgeons generally. Then also an attempt has been frequently made to dilate a stricture by means of a single instrument which expands *in situ*, in the place of several instruments of increasing calibres which require to be successively pushed through the constricted part. With this object Mr. Luxmoor (1812) employed diverging metal rods; Leroy d'Etiolles the same method, some years later; and M. Perrève a somewhat similar plan (1847); Dr. Arnott commenced the employment of fluid expansion (1819). In a lesser degree, the accomplishment of the same object has been attempted by the use of catgut bougies, and very recently by bougies of Laminaria, a species of seaweed which expands in contact with moisture. A German surgeon formerly, and Reybard of Lyons more recently, have employed metallic expanding instruments for the same purpose; although the latter chiefly employed such instruments for maintaining apart the incisions after urethrotomy. But he proposed this method also for effecting dilatation by progressive steps, with the view of carrying it to a higher degree than could be attained by any instrument the extent of whose expanding power is limited by the size of the external meatus, which is well known to be the narrowest part of the urethra. Perrève of Paris (1847) has attempted to dilate by passing cylinders of gradually increasing diameter between two blades previously passed through the stricture as a guide for the cylinders. (See his instrument, fig. 41.)

In considering these and numerous similar means which have been employed, it is impossible to forbear remarking that, to effect dilatation, complicated apparatus is

FIG. 41.—The instrument employed by Perrève (from his work).



not so efficient or so desirable as the employment of a simple bougie, when passed with gentleness, and with a light hand. Were catheterism simply an affair of overcoming mechanical resistance, the expedients of the engineer would naturally commend themselves; but we must remember, in the prosecution of dilatation, that the urethra is endowed with vital functions and relations of the highest importance.

Forcible dilatation was some half-century ago systematically employed by Mayor of Lausanne, who endeavoured to accomplish it by driving large conical metal bougies through the obstruction. His method gained much notoriety for a short time, but was soon abandoned on account of the disastrous results it produced in the hands of most surgeons.

More recently Mr. Holt has introduced the treatment by 'rupture.' He adopted Perrève's instrument, which he introduces through the stricture into the bladder, and then, instead of passing gradually tubes of increased size, he at once forces the largest tube along the central guide down the urethra, so as at one stroke to split the obstructing tissues. While this proceeding, which is extremely easy of performance, has been largely adopted, and with a fair amount of success, it is by no means without risk; and the relief afforded in advanced cases is often of only brief duration.

I myself also formerly employed a two-bladed distending instrument, the power of which was exerted, and to a very considerable extent, only on the part of the canal in which the stricture was situated; but I have relinquished both this and the preceding by rupture, being now firmly convinced, from a long experience and comparison of methods, that internal urethrotomy properly performed is a safer and more efficient operation than either.

To return to the subject of gradual dilatation, and particularly to its employment for old and irritable strictures: in such cases, it is necessary to proceed with great caution. More progress will be often made by employing those adjuvants, which deranged health requires, than by pertinaciously continuing the use of the bougie when the stricture is unusually obstinate. Further, having arrived at any given number in the scale, say six or seven, beyond which it is difficult to proceed, we should employ half or intermediate sizes, which I have long used; or employ the French scale, which, as already seen, admits of more gradual steps in the treatment.

There are not a few cases, however, in which, notwithstanding our care, the patient's existence is barely a tolerable one. The urethra and bladder are sensitive, or the stricture is so contractile, that fever, or retention of urine, frequently occur. These facts, recognised by all surgeons of experience, have led them to adopt other methods. The next to be considered is the treatment by caustic agents.

1. *Caustics*.—During three centuries at least, escharotic substances have been employed to destroy the obstructions, in earlier times supposed to be 'callus' or 'caruncle,' which oppose the passage of the urine. With this view, savin, antimony, mercury, verdigris, quicklime, vitriol, alum, and other active agents have been carried by some contrivance or another down to the stricture. John Hunter, in the latter part of last century, brought into note the nitrate of silver; and Mr. Whately, in the commencement of the present century, the caustic potash. These substances have been supposed by their advocates to act, first, by deadening sensibility, and thus allaying spasm; secondly, by causing to slough, and so destroying, the morbid tissue of the stricture itself; and lastly, by dissolving or softening that tissue, and thus permitting instruments to be passed. Although these agents became popular, they have long ceased to be used by surgeons. It was found impossible to limit the application of any soluble substance to a given portion of the urethra, while their use is by no means free from painful and even dangerous results, such as violent spasm, retention, and fever. Moreover, there is no doubt that these caustics in time produce increased induration, and the formation of fresh contractile tissue. On the other hand, the advocates of potassa fusa were wont to claim, that after its use the catheter is more easily passed; and that, in cases in which they have been unable to pass any instrument at all, this agent has frequently been successful: while numerous results of this kind may, they say, be referred to. Perhaps the opinions and practice of the profession abroad, in reference to caustics, cannot be more truly or concisely

represented than in a late record by Nélaton, who stated that ‘cauterisation of any kind is rarely employed now, on account of its uncertainty and the tumefaction of the urethra and retention of urine which it produces, and the new formation of contractile tissue which is likely to result.’¹ In like manner, the widely received opinion in England was thus expressed by Mr. Erichsen : ‘This practice, stigmatised by Mr. Liston as “most atrocious,” has now but few advocates ; and, indeed, there appears to be nothing that it effects but what can be accomplished much more safely and easily by a catheter or sound in an ordinary skilful hand.’² It may be added, that my own observation and experience has led me fully to coincide with the opinions thus expressed. It may not, however, be altogether out of place to say a word or two as to the method of employing these agents. Thus the nitrate of silver has been applied by passing a small stilet, on which the salt has been fused, through a hollow cannula to the stricture, with which the agent is to remain in contact for a few seconds. The potassa fusa was employed by attaching a small fragment, the fourth or the half of a grain, to the end of a wax bougie which is to be pressed for a moment or two against the obstruction, which stops the instrument in its progress along the urethra.³

2. *Urethrotomy*.—Under this term are included numerous modes of dividing the morbid structure which surrounds and narrows the urethra. All may be arranged in two classes : the first contains operations in which the incision is made altogether within the urethra ; the second, those in which incisions commence from without, usually in the perinæum, and are carried into the urethra and through the seat of stricture.

The first, or internal, urethrotomy will now be considered. This method of dealing with obstinate stricture has been practised for above a century. Long before that time internal incisions had been combined with the use of escharotics, although it does not appear that they were employed alone much before the period named. Allies of France (1755), Physick of Philadelphia (1795), John Bell (1806), Charles Bell (1807), M’Ghie (1823), and Stafford (1827) have employed different instruments and different modes of performing internal incision. Modified forms of some of these have been occasionally adopted by modern surgeons in this country ; but the method has been practised much more extensively in France, where very numerous forms of urethrotome have been designed.

All belong to one of two classes : in the first, section is made by pushing downwards a sharp blade, generally with a slender conductor in advance of it, into the obstruction to be divided—incision from before backwards ; in the second, a portion of the instrument containing a small blade sheathed, is first carried through the stricture, which is divided by protruding the blade and drawing it outwards through the whole of the contracted portion—incision from behind forwards.

Incision from before backwards.—Whenever this mode is practised, a guide should be previously passed through the stricture into the bladder, to insure an accurate course for the blade : formerly incisions were made without any guide—a method now wholly discountenanced, on account of its uncertainty and danger. This proceeding has usually been considered more applicable to obstinate strictures which are situated within three or four inches of the external meatus, provided they are not greatly indurated, than to those which are more deeply placed, although it is equally possible, with modern instruments, to employ for these also. The urethrotomes of Ricord, Mercier, Reybard, Trélat, Charrière, and others have each been adopted in turn abroad. In this country but few have pursued the method in any form. The author formerly designed a ‘catheter urethrotome,’ the peculiarity of which is that every step of the process is mechanically certain and safe, after a No. 2 silver catheter has been passed. The catheter having withdrawn the urine, and thus

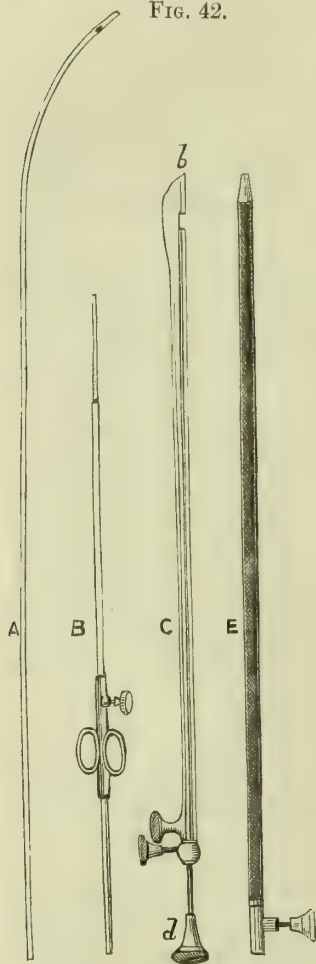
¹ *Éléments de Path. chir.* Paris, 1858, tom. v. p. 409.

² *Science and Art of Surgery*, 2nd edit. Lond. 1857, p. 925.

³ Further information may be found in the works of B. Phillips, who first advocated and subsequently repudiated the employment of caustic ; of Dr. Jas. Arnott, Mr. Wade, and Mr. H. Smith.

proved that the instrument is not in a false passage, the blade slides along it through the stricture, is then withdrawn, and a large gum catheter is passed over the small catheter, which, being also withdrawn, concludes the operation (see fig. 42). This remains for forty-eight hours; and dilatation is subsequently continued, but the method described is rarely necessary. The incision from before backwards has come more into use on the Continent within late years, since the appearance of Maisonneuve's urethrotome (see fig. 43), associated or not, as the case may require, with the use of a fine flexible guide, which precedes the instrument in its passage through the stricture,

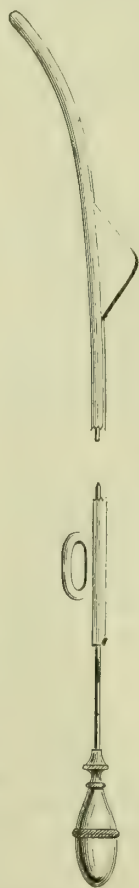
FIG. 42.



A, a grooved silver catheter, size of No. 2, by which the urine is withdrawn. B is a rod of the same size, which screws into the end of the catheter. C is the urethrotome; *b* the blade sheathed; *d* the handle which unsheathes it. This instrument passes down a groove in A, and, after incising the structure, is withdrawn; when E, a gum-elastic catheter, is passed into the bladder over the catheter and rod, AB.

and is pushed onwards into the bladder. The salient angle of Maisonneuve's blade is blunt to permit of its traversing the whole canal without inflicting injury, except at the point of stricture, some of the tissues of which are necessarily divided by the cutting face of the blade as it is pushed onwards through it along the groove. But the blunted angle referred to renders the instrument imperfect, inasmuch as it fails to cut the most elastic or yielding fibres of the stricture, which, by reason of their yielding character, permit the blade to pass through by stretching them.

FIG. 43.—Maisonneuve's Urethrotome.



Neither is it possible by any mode of using the instrument to control or regulate its power, and it is thus unquestionably inefficient for those confirmed and indurated strictures which are precisely those which require treatment by complete division. This urethrotome has been modified by Sédillot and Voilemier in France, by Berkeley Hill and others here, more or less improving it; but, notwithstanding these changes, the objection remains that its action is purely mechanical, not susceptible of being intelligently modified at the will of the operator.

Of late Dr. Otis of New York has advocated a combined method of stretching the urethra and cutting it at various points, so as to ensure a considerable amount of patency throughout. He uses a dilating bulb of large size to examine the urethra with, before operating, and by which it is not difficult to recognise several inequalities in calibre at different situations in the canal. All these he aims at dividing by his urethrotome.

The method is in the highest degree mechanical, and its results, so far as they have been observed in this country, have not obtained for it a high estimation here.

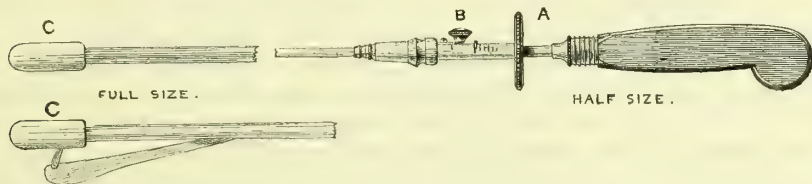
Incision from behind forwards is on the whole a more certain and effective method than any of the preceding; and it is applicable equally to all parts of the canal. It requires generally, however, that the stricture should be dilated sufficiently beforehand to admit that part of the urethrotome which contains the blade to pass through and beyond, before the incision can be made; and this portion is necessarily equal in size to No. 4 or 5. This preliminary dilatation is accomplished by the

'continuous' process. It has often been objected that if we can pass a No. 4 or 5 through a stricture, there can be no occasion to employ any cutting instrument at all. But such a remark is based on defective acquaintance with the subject. The indication for a cutting operation is not that the *stricture is of very small calibre, but that it is non-dilatable*—that is, that its calibre cannot be permanently increased by the most persevering and judicious application of instruments, or that so much fever and distress are produced by them as to counterbalance the benefit of any dilatation they may effect. Thus, a stricture may at the outset of treatment not admit even a No. 1 bougie, yet in a short time it may be easily dilated, and show only slight tendency to return, easily counteracted by occasionally passing an instrument; on the other hand, a stricture which habitually admits No. 6 or 7 may be the cause of the greatest suffering, of almost daily retention, and be irritated instead of benefited by all attempts to dilate. It is in such cases, happily not frequent, that incision has proved of very great service. I have rarely experienced better results from any operation than those obtained from internal urethrotomy in cases of the kind described.

Before employing any form of internal urethrotomy, it is necessary to make an accurate survey of the entire urethra, so as to have a clear idea of the narrowed point or points, their extent and situation in the canal. This is accomplished by using the bulbous sounds before described (page 214), and exploring every part from the external meatus to the prostate. Having a clear view of the portions requiring to be divided, I use my modification of Civiale's urethrotome by preference to any other (see fig. 44).

In this instrument the blade lies concealed in the bulbous extremity, from which, by means of a simple contrivance in the upper end of the sheath or cannula, it can be made to project one, two, three, or four degrees, according to the depth of the

FIG. 44.—The author's modification of Civiale's Urethrotome.



incision intended (see fig. 44 c). The mode of proceeding is as follows: Having sufficiently dilated the stricture, so that it will admit about a No. 4 or 5 bougie, the previous examination of the obstruction is verified by the urethrotome itself, the bulbous end of which forms a useful sound. This bulb is carried about one-third of an inch or more beyond the stricture, the blade projected, and the incision made by drawing it slowly but firmly outwards—that is, in a direction towards the external meatus—to the distance of an inch and a half or two inches, generally towards the floor of the urethra, so as to incise fully the stricture and a little of the sound urethra before and behind it. All the thickened tissues which constitute the stricture should be divided, or the result will be incomplete. After this, a metallic bougie, No. 14 at least, should be passed, and if it is held closely at any point, there is still almost certainly some portion left which requires to be touched with the blade—its situation can be ascertained with a large bulbous sound; ultimately No. 16 should in most cases pass with perfect freedom; I am not satisfied with less. Next a No. 11 or 12 gum-catheter is introduced and retained at least for twenty-four hours; and even forty-eight if there has been a little undue bleeding. I have seen on one occasion some extravasation of urine after a too early removal of the catheter. Subsequently a full-sized bougie should be passed every four or five days for a few times, then every week, and lastly once or twice a month. Hemorrhage to any considerable extent is rare; if it is free, a full-sized instrument in the urethra, and external cold, will stop it. Febrile symptoms occasionally show themselves after the operation, as in other modes of treatment, and disappear without remedial means. In relation to the accidents which may immediately follow the operation, the following is the result of about three hundred cases of urethrotomy performed by myself in the manner described.

In those practised for stricture situated in the urethra in front of the scrotum, I have seen no ill effects whatever. In those practised in the bulbous part of the urethra, I have occasionally seen free and once dangerous hæmorrhage; very rarely abscess, extravasation of urine, inflammation of the bladder or kidneys, or pyæmia. Such occurrences are occasionally met with, but in a very few cases out of so large a number.

In relation to the positive benefits which are to be obtained, the immediate result is perfect. Properly incised, there is no longer the slightest grasp on the largest instrument introduced, and it is often difficult to recognise the seat of the former contraction.

In some cases these results are maintained for a very long period; in others, the stricture in a few years shows a tendency to return; but as in external division, so in internal, the contractility and the non-dilatability—those characters which have been before shown to be the indications for resort to operative procedure—are generally much diminished in intensity; and if subsequent treatment be necessary, dilatation usually suffices; if not, another urethrotomy should be performed. I have had excellent results from a second operation in old-standing cases, in which I had performed a primary one, at such varying periods as from seven to twelve years before.

Such have been the general results of urethrotomy, when properly performed, and applied to suitable cases. I think it right, however, to add here, that my observation and experience of distension at a single sitting, or by rupture, have convinced me that we may thus produce excellent results at first, which, however, are not often durable; so that these methods will by no means supersede internal incisions. For all non-dilatable strictures situated from two to four inches from the external meatus, I decidedly prefer internal urethrotomy: the operation is perfectly safe and easy to perform, and its results more lasting and complete than any other.

Incision is especially applicable to a common form of stricture which occurs at, or very near to, the orifice of the urethra. It may be congenital, the result of inflammation, of cicatrisation after chancre, or other lesion there. It may be the only obstruction in the canal, and yet give rise to painful and serious symptoms, and even to a fatal result. I have repeatedly given complete relief to distressing symptoms, the cause of which was not suspected, by dividing an external meatus, which admitted nevertheless a No. 5 or 6 catheter. The incision may be performed with a director, and a straight, narrow-bladed bistoury; a useful instrument is a small *bistouri caché*, passed through the contracted part of the canal; the blade opened to an extent previously determined, and drawn out, with the edge towards the frænum, and a free section made. A piece of dry lint, introduced for an inch and left there, generally stops the bleeding; if not, an artery forceps or a ligature may be applied. After a day or two, the patient introduces a short conical metal bougie, about three inches long, and provided with a handle sufficiently large to prevent its slipping into the urethra.

The late Mr. Colles, of Dublin, adopted a method of treating some of these cases which deserves notice. It consists in drawing over the surfaces divided by the section described the two edges of urethral mucous membrane, and stitching them to the external margins of the wound, each lip of which is thus covered by membrane, and prevented from adhering to its fellow.

External urethrotomy.—The division of the tissue composing the stricture is sometimes effected by incisions commenced from the external surface. Various external operations, although designed mainly to relieve retention of urine, were made at a very early period, according to Rhazes (10th century) and Avicenna (11th century). The earliest operation for the cure of stricture apart from retention, but in which the surgeon could pass no catheter, is recorded by Wiseman (1652). A few years afterwards, Solingen at Livourne (Leghorn) adopted a similar course. François Tolet and Colet (1690) appear to have performed similar operations in France. J. A. Petit and Ledran (1740) also, not infrequently. In 1783 John Hunter performed the operation now known, and described hereafter, as the perineal section; but it was rarely employed until Mr. Grainger of Birmingham advocated

it in 1815. He was followed by Mr. Arnott; since which time it has been the proceeding ordinarily adopted for extremely obstinate cases, when the surgeon has been unable to pass any instrument through the stricture. More recently (1844) Mr. Syme has advocated the division of the stricture in exceptional cases, where, although a catheter can be passed into the bladder, no treatment has afforded permanent relief. This operation he called 'external division,' a term which should be reserved for his method; while it is equally desirable to limit the use of the term 'perineal section' to the proceeding just referred to for strictures which have been found impervious to the catheter.

Perineal section, or the operation without a guide, employed for so-called 'impermeable' stricture, is less frequently performed now than it was some few years ago. There has been a growing belief that few, if any, strictures exist through which, if the urine issues externally, a catheter of appropriate size may not be passed with care, gentleness, and skill. This opinion, after a large experience of stricture in its worst form, I entirely endorse; and have no hesitation in stating, as a general rule admitting of very few exceptions, that no stricture permeable to urine is impermeable to an instrument, providing that that instrument is sufficiently small, and is used with the utmost gentleness and care. If, however, the surgeon meets with an exception to this rule, this operation, which I have had occasion to perform only three times in my life is admissible. The method of performing it should be that devised by Mr. Wheelhouse of Leeds. A straight grooved director, with a slightly hooked extremity, the groove ceasing within a quarter of an inch of the end, is passed down and rests lightly against the stricture. A median incision is made in the perinæum and falls into the urethra, only a quarter of an inch above the end of the director, and therefore into the groove, not exposing the hooked extremity, which is now turned round to the front, made to hook up the upper angle of the wound, and held steadily by an assistant. Two others hold each one side of the wound apart with forceps, exposing the urethra where the anterior part or face of the stricture must be situated. Searching with probes, this will now be found and opened, and the director ultimately carried through the whole, so that free division of the entire stricture is accomplished.¹ A catheter is then tied on for a few days in the usual manner.

External division.—First, a clear idea of the precise situation and extent of the stricture must be formed before commencing. Next, the patient being placed as for lithotomy, a staff, the lower half of which is slender and grooved, and the upper of full size, is passed so that the shoulder or edge of the thick portion rests firmly against the face of the stricture, the slender part passing through it into the bladder. An assistant holds the staff in his right, and draws up the scrotum with the left, hand. The operator makes an incision in the line of the raphé from above downwards, about two inches long, continuing it until he can distinguish the shoulder of the staff, and by that is guided to the position of the stricture, when, taking a sharp straight bistoury in his right hand, and the staff itself in his left, he engages the point in the groove of the staff about an inch below the shoulder, and cuts upwards, dividing the tissues, to the upper end of the groove. If the stricture has been properly divided, the shoulder of the staff may be passed downwards through the incised part with ease, and, if so, is withdrawn, and a large gum catheter passed in its place. As this sometimes does not go readily into the bladder, I introduce by the wound, before withdrawing the staff, a concave curved director along the convexity of the staff, on which the catheter glides securely into the bladder. If the catheter, however, encounters difficulty, and is obviously grasped after it has been passed, some fibres still require division, and these should be at once incised.

At the end of forty-eight hours the catheter is to be withdrawn; and about three days after a full-sized sound should be passed. Subsequently this is passed once a week, and then less frequently, as circumstances require.

Results of treatment by external incisions.—In reference to the operation without a guide, or the perineal section, no surgeon should perform it except after thoroughly assuring himself that the stricture cannot be rendered permeable to instruments, and so

¹ *Brit. Med. Journ.* June 24, 1876.

made amenable to other modes of treatment. In some cases the operation is performed successfully, and with advantage to the patient, but in some there can be little doubt that the route of the stricture itself is not followed, and that the knife makes a new channel through adjacent and often very unsound tissues, very inadequate to perform subsequently the function of a urethra. In a few instances the attempt to make a channel to the bladder has wholly failed, and the patient has been removed from the operating-table unrelieved; and the result of the proceeding has been fatal.

Respecting the operation of external division, or that performed on a grooved staff, it is applicable only to cases which present an insuperable tendency to contract after dilatation, and in which the existence of intractable perineal fistulæ demands some such operation.

Hæmorrhage, not considerable, sometimes occurs either at or after the operation. Very rarely is it serious; and when it is, there ought not to be difficulty in stopping it. A full-sized catheter being in the urethra, it is necessary to plug the wound with lint, and maintain a firm pad of the same material over it, by means of a T-bandage closely applied. In one case I found the perinæum greatly indurated with several fistulæ, and had obstinate bleeding from vessels which the ligature would not hold, owing to the nature of the tissue in which their mouths were embedded; but I succeeded by carrying a small curved needle beneath each bleeding point. In regard to the remote results of the operation, there is undoubtedly more or less of recontraction after the lapse of time. This has chiefly arisen from not dividing the entire contracted portion of the urethra; in other cases from neglect of subsequent dilatation. On the other hand, in some cases, I have been able to verify long periods of freedom from symptoms, and very slight recontraction, for considerable terms of years after the operation. Probably the after results are much the same as those which follow an efficient internal urethrotomy.

SPASM OF THE URETHRA.

It is extremely rare than any considerable closing of the urethra takes place as the result of pure spasm of the muscles surrounding the passage. Granted, however, the presence of true stricture, or of inflammation in the canal, an undue action of the urethral muscles may be excited, so as still further to narrow it. No doubt a slight degree of this action may be excited in any part of the passage; but it is more obvious in the membranous part, where sphincteric muscles exist in addition to those unstriped fibres which surround the canal throughout the whole of its course. Nevertheless the existence of 'spasm' is very constantly and very frequently affirmed, often without any proof of its presence, usually in order to account for unsuccessful catheterism.

As immediate causes of 'spasm' may be named the following: the presence of organic stricture; of inflammation from repressed gonorrhœal discharge; irritation of the mucous membrane from highly acid or acrid urine; from foreign matters ingested, and expelled by the urine, as cantharides, turpentine, and perhaps some forms of condiments and of alcoholic drinks; and from voluntary retention of urine. Examples of remote causes of spasm are hæmorrhoids, fissure, prolapsus, fistulæ, operations on the rectum, ascarides, prurigo about the anus, derangements of the digestive apparatus and of the cerebro-spinal system. But it is important to remember that the distinguishing feature of phenomena ascribed to irregular muscular traction, and by which they are contrasted with those of organic stricture, is their transitory character. This is never the case with the symptoms of organic stricture; the stream then varies, but it never attains the natural size.

In treating spasm general principles must be kept in view, and applied according to the particular requirements of each case. The chief rule is not to regard so much the system itself as to investigate the cause, a correct appreciation of which is the key to successful treatment. The cause must be sought not only in the urinary tract, but in adjacent and allied organs, and in the condition of the system at large. Speaking in general terms, attention directed to the condition of the animal powers,

to the improvement of the secretions, and to the regulation of the regimen and habits of the patient, will conduce more to the removal of the local symptoms than any measures apparently of more direct or special application. I have known one instance of spasmodic retention to occur periodically, and to disappear before the use of quinine: Sir B. Brodie records one similar case. A hot hip-bath, or the inhalation of ether, may sometimes give instant relief. For the most part, however, spasmodic action in the urethra is associated with inflammation affecting the canal, and especially when inducing retention of urine. (For further notice of its treatment see 'Retention of Urine,' p. 228.)

Inflammation.—The pathological condition usually present in what has erroneously been called 'inflammatory stricture' is acute inflammation of the prostate, with swelling of that gland (see p. 196). The patient complains of heat, fulness, and tenderness in the perinæum; the passing of the urine is exquisitely painful; the stream narrows rapidly during the act of passing it, and ceases before the bladder is emptied or the desire diminishes. Usually it is found on inquiry that a recent purulent discharge from the urethra has been suddenly checked, and the signs of fever are usually present. As this condition mostly comes under the surgeon's notice for relief of retention, the treatment will be found under the head of acute prostatitis.

Tumours of the urethra.—The cause of urinary obstruction was formerly supposed, in nearly all cases, to be the existence of 'carinosities' or 'caruncles' growing from the mucous membrane of the urethra. Such bodies do exist, but they are excessively rare.

Pascal (1718) describes two cases of small fungoid excrescences in the urethra. Morgagni (1761), in his forty-second letter, speaks of one which he had seen among many examinations. Arnaud (1769) names three instances. Hunter met with two cases: one is in the Museum of the Royal College of Surgeons. Sir Charles Bell describes and figures two cases. Amussat, Civiale, Lallemand, Ricord, Chelius, Leroy, and Mercier, all describe occasional cases seen by themselves. Guthrie and others in this country have met with a case occasionally. A specimen of polypoid growth from the mucous membrane of the membranous portion exists in the Museum of Guy's Hospital. I have myself met with a good example of small polypus springing from the verumontanum, in a man aged fifty-four years, a patient in the St. Mary-lebone Infirmary. The only sign of its existence, which could be ascertained during life, was an increased frequency of micturition. Those which are found at the anterior part of the canal, and which appear almost confined, as regards situation, to the fossa navicularis, are usually soft, of a rose-red colour, bleed very readily, and are indeed an intra-urethral form of wart.

The conclusions respecting growths into the urethral canal are:

First, that the existence of any excrescence so large as to attract observation as an independent growth in the urethra is extremely rare.

Secondly, that these bodies consist either of (a) *vascular granulations*; (b) *polypoid formations* peculiar to the prostatic part of the urethra; or (c) masses of *tubercular* and *cancerous* origin: always secondary to primary disease elsewhere.

Urinary abscess is most frequently, but not invariably, a result of obstruction in the urethral canal. It may be regarded in reference to its situation as penile or ante-scrotal, scrotal, perinæal, and intra-pelvic. Among these the perinæal is the most common, next comes the scrotal; the intra-pelvic occurs usually in very advanced cases of stricture, &c., and the penile is rare, mostly caused by acute gonorrhœa.

When urinary abscess occurs without obstruction in the urethra, there is reason to suspect that disease exists at or near the neck of the bladder, particularly disease of the prostate. Ordinary perinæal abscess may be acute or chronic: the former usually requires prompt interference on the part of the surgeon, and its presence is often indicated by constitutional symptoms before local signs appear. If there are tension, fulness, and tenderness in the perinæum, a free and deep incision in the middle line will often give instant relief: and if matter is not seen at once, such a proceeding will do no harm, although nothing happens, but a little bleeding, and the relief of tension. No considerable hæmorrhage need be feared, although sometimes oozing may continue for some time. When it has ceased, a poultice should be applied to the

wound. After this the patient often improves, the fever subsides, and recovery follows speedily.

The importance of opening these abscesses soon, cannot be overrated. Matter pent up behind the deep perineal fascia may find its way into the cellular tissue of the pelvis, by the side of the bladder, between it and the rectum, and give rise to dangerous consequences, or, in event of recovery, to urethro-rectal or vesico-rectal fistulæ. Otherwise it may burst into the urethra, and be discharged by the external meatus. The collection having been opened, pus in some quantity escapes, usually alone, sometimes mixed with urine, but not necessarily so. One of the main objects in making an early opening into an abscess in the perinæum is to prevent lesion of the urethral walls; if evacuation be soon insured, the cavity may gradually close, and not become an abnormal passage for the urine.

In the case of chronic abscess, an incision should be made when the presence of matter is perfectly evident. Such abscesses are usually situated near the bulbous portion of the urethra, and appear in the perinæum and scrotum; sometimes as the result of ulceration behind the stricture, and escape of a drop or two of urine into the cellular tissue; oftener, perhaps, from the adjacent irritation, without direct communication at first with the urethra. This communication almost invariably takes place if the abscess breaks of itself, sometimes when it is opened by the knife; but when opened early, generally no urine appears until some days after the operation, and occasionally not at all. An unnatural opening, however, being established, the passage of urine through it, which occurs at each act of micturition if the stricture be narrow, prevents its closure. This artificial canal, usually termed urinary fistula, is a common accompaniment of neglected stricture and often a troublesome complication.

Urinary fistulæ.—Their external openings are mostly seen in the perinæum and scrotum, which are traversed by them, often in circuitous routes; less frequently they appear in the groins, the upper part of the thighs, the adjacent part of the nates, or even above the pubic symphysis. In the last-named situation, a fistula usually results from incisions made to relieve extravasation; but in the scrotum or perinæum it is generally due to a previously-existing urinary abscess.

Under the term 'urinary fistulæ' all these conditions are commonly included; some of them simple, and easily amenable to treatment; others complicated, and requiring much care and time in order to attain a successful result. Some are merely narrow channels through nearly healthy parts; others pass through structures indurated and deformed by repeated deposits of plastic matter, and sometimes connected with cavities secreting pus, and detaining in their interior urine as it passes. The external orifices of the fistulous passage may be few, or numerous, and giving exit to a number of small streams when micturition is performed. And lastly, there are those openings into the urethra which have their origin in loss of substance after sloughing ulceration, or injury to the parts. Thus, under the general term urinary fistulæ three forms are indicated, each requiring appropriate treatment.

1. *Simple fistulæ.* The first class embraces those cases where one or more fistulous passages exists, the surrounding parts being not much altered from their natural or healthy condition. They are the result of nature's mode of affording relief in cases of narrow stricture; and patients may enjoy fair health, notwithstanding large fistulous passages, by which all the urine is passed. But the annoyance, sometimes the pain, besides the tendency to grow worse, which accompany urinary fistula, demand an attempt to bring about a natural state of things.

For these cases, as a rule, nothing else is required than to dilate fully the urethra. The urine will flow by the natural channel, and the fistulæ will heal of themselves, if we insure a patent urethra. Exceptional cases are for the most part weak in constitution, have little reparative power, and their treatment follows with that of the next class.

2. Cases in which the fistulæ pass through tissues indurated and deformed by inflammatory exudation. Here our first duty also is to dilate the stricture, and in some few cases the fistulæ will then heal slowly. Dilatation, however, having been maintained for some time, and little or no benefit having resulted, it used to be the

fashion to employ various local agents to stimulate the interior of the fistulous track by the galvanic wire, or by applying solutions of nitrate of silver, of copper or of cantharides. Probes coated with the first named were passed as far as possible, while caustic potash was applied to the narrow orifices to insure a sure exit for matters discharged. Again, external pressure has occasionally been successfully employed. Still more commonly the case has been attempted, by tying in a catheter, for days together, to insure, as it was supposed, the issue of urine through the instrument, and thus preventing it from irritating the fistulous passages. But experience shows that, however closely the instrument may fit the urethra, the urine will soon pass at the side.

A far more efficient plan is to withdraw all the patient's urine, by introducing a catheter several times a day. When the patient can do this cleverly for himself, and thus insure, at every want to pass urine during a period of a few weeks, that it is removed without contact with the urethra, a successful result may be hoped for. I have had numerous examples of this in some which had been previously most obstinate cases. Failing by this means, free incisions through the fistulæ, down to their origin in the urethra, or nearly so, are mostly successful in inducing healthy granulation from the bottom of the wound, and ultimately closing the unnatural passages; provided always, however, that the stricture is amply dilated, otherwise no measures can be of any service. In those cases in which external division of the stricture on a grooved staff is indicated, this operation may be performed so as to include the fistulous openings in the incision, in which case a successful result may generally be reckoned on. An obstinate fistula communicating with the urethra, sometimes follows the operation of lithotomy; this may be successfully treated by the introduction of a wire heated by the galvanic current.

A fistulous passage is sometimes prevented from closing by the presence of a small calculus or concretion which has escaped from the bladder, or as a deposit from unhealthy urine while passing through the sinus. Sometimes it occurs in fistulæ connected with diseased prostate, or with a prostate which is the subject of calculous formations. Fistula associated with the prostate may, however, exist in the absence of any of these causes; such as those very rarely connected with prostatic abscess, and which are generally exceedingly obstinate and irremediable.

Urethro-rectal fistulæ sometimes occur as a consequence of stricture or abscess, and more rarely, perhaps, vesico-rectal. Sometimes they follow lithotomy, as when the rectum is wounded in that operation. In any case their existence is usually announced by the passage of liquid by the anus; or by the appearance of feculent matter in the urine or by the urethra. I had once a case of urethro-rectal fistula in a patient twenty years of age, the result of prostatic abscess following gonorrhœa. The urine passed freely by the anus for some weeks. After trying various means, the use of the catheter, &c., without success, I discovered that by placing him flat on his face during the action of micturition, almost all the urine passed by the urethra. This plan was adopted for three months. Urine ceased to pass altogether by rectum in a month, and in two more he could pass it in the upright position without any escape. The fistula has remained soundly healed ever since.

If such a plan does not succeed, the galvanic wire affords the best chance of success. It may be applied through the rectum; a speculum having been first introduced, and a full-sized sound carried into the bladder. The bowels are first to be freely opened, and cleared by an enema before the application of the cautery, after which they must be prevented from acting for two or three days. The cautery is to be re-applied two or three times if necessary. If the opening is large, the edges may be pared and brought together by sutures; these measures are mainly applicable after the wound in lithotomy.

3. The third class of urinary fistulæ comprises those which depend upon destruction of the walls of the urethra and superjacent parts. The common causes are, sloughing from extravasation of urine, simple and phagedænic ulceration, and mechanical injuries of various kinds. They are for the most part larger, although not invariably so, than any of those already referred to. Generally a portion of the urethra is destroyed, as well as the structures between it and the external surface;

so that some of the mucous membrane of the upper aspect of the canal is visible from the outer orifice. As a consequence, all, or nearly all, the urine passes by the opening in a full stream. Such fistulæ may be found before the scrotum, and are called ante-scrotal or urethro-penile; or in or behind the scrotum, known simply as scrotal and perineal fistulæ. A broad distinction exists between these two classes in relation to treatment, and to the nature of the operations necessary for their cure. Ante-scrotal fistulæ are difficult to close, since the coverings of the urethra here are thin; while, owing to the mobility of the penis, it is difficult to maintain the steadiness of position necessary in a part which is the subject of an autoplasmic operation. Nevertheless, with all these difficulties, in addition to that formidable one, the contact of urine, such openings, even when large, are not beyond the reach of surgical skill. The exercise of considerable patience and attention during a long period are indispensable, both to the surgeon and to the patient, in a case of urethro-penile fistula requiring a plastic procedure for its cure.

Treatment.—Ante-scrotal fistulous openings of small size have been closed by repeated applications of a caustic agent to their edges, such as nitric acid, nitrate of silver, or strong tincture of cantharides.

Dieffenbach used the cantharides, combining with it what he called 'the lace suture,' for small fistulæ in the anterior part of the canal. The margin of the fistula and the surrounding skin are freely touched the day previous to operation with strong tincture of cantharides. The loose epidermis is then removed by scraping, and a sound introduced into the urethra beyond the opening. The operator takes a small curved needle, sharp at the point, with a silk wax thread, and introduces it beneath the skin at about three lines from the border of the fistula. The point of the needle is carried deeply, but not into the urethra, and made to emerge at another point, three lines from the margin of the fistulous opening. By three or four of these stitches, the thread is carried round the opening, until it finally emerges at the point at which the needle originally entered: and the thread lies in the cellular tissue around the fistula, at about three or four lines' distance from it. Its ends are now drawn together slowly, so as gradually to approximate the borders of the fistulous orifice until it is obliterated, and then to be fastened by a knot. In three or four days the ligature may be divided and drawn away. Most commonly, however, some plastic operation is necessary for these openings. The systems of Cooper and Earle, the first on record, are the basis of many various proceedings since employed. Two of the modes for ante-scrotal opening are described in the essay on PLASTIC SURGERY: I have given others in my own work on 'Stricture' and 'Perineal Fistulæ' in some detail.

Retention of urine.—This term implies a condition in which the patient is unable to pass any urine whatever, or only a very small quantity; and is in danger of serious consequences if not speedily relieved. Urine may be, and often is, habitually retained in the bladder, although the patient passes a full quantity daily, the reservoir, however, never being emptied. This is engorgement of the bladder, and is not retention, which term indicates an acute and not a chronic condition.

Retention of urine may be caused by simple prostatitis, usually in young and middle-aged subjects; by stricture of the urethra, usually in middle life; and by hypertrophied prostate, in elderly persons only.

The consideration of the first and second forms comes next in order here.

Complete retention.—When organic stricture exists, retention of urine is always possible if exposure to certain influences takes place. Occlusion of the passage may be caused by inflammation or unwonted muscular contraction; or by a combination of both. Sometimes it may be caused by a foreign body, as a small calculus, a portion of a membrane, or the like, obstructing the stricture; and this is a rarer form.

In treating retention, the catheter is the first means required in nine cases out of ten, and often the only means. The first point to be ascertained is, is the case one of merely temporary obstruction from inflammation, or does it depend on old-

standing stricture? The next points are the duration of the attack and the condition of the bladder, bearing in mind that while some patients may exhibit distension of that viscus almost to the umbilicus, the subject of an old stricture may be in a state of greater danger, although no distension is perceptible above the pubes, owing to the contracted condition of the bladder, which has become natural to him. The treatment varies somewhat in the two cases just briefly described. In the case of temporary inflammatory obstruction, it has been recommended to employ baths, opium, and depletion before using the catheter; and relief may certainly be afforded in this manner, but mostly after prolonged suffering to the patient. The object is to avoid injury to the inflamed urethra; and if the surgeon is not skilled in the use of the catheter, it may be the safest course. But if he employs a light hand, a flexible catheter of rather small size, say No. 4 or 5, should be at once passed into the bladder; and this is generally easy enough. If he fails the patient should have a hot bath, 100° to 105° or 108° , to relax spasm and relieve congestion; a full dose of opium by the mouth; and if there is much straining, an opium suppository may be given also.

If there is much inflammation evidenced by a swollen penis, urethral discharge and tender perinæum, a dozen leeches on the latter region are useful, in the event of retention persisting; relief, however, generally follows the bath and opium, which latter may be repeated two or three times, to ensure its full action on the system. There are very few inflammatory or spasmodic cases that will not yield; if not, an instrument may often be passed with comparative ease after the treatment described. In some instances, apparently more spasmodic than inflammatory, repeated doses of the tinct. ferri perchlor.: say 15 or 20 minims every half-hour, administered four or six times, have been sometimes found to relieve the retention.

But when we have to deal with retention from confirmed stricture, it is better at once to examine the urethra with a full-sized instrument, to ascertain the locality of the obstruction, and then patiently attempt to pass one of the smallest catheters, silver or gum. In relation to their management, see pp. 215, 216, on Catheterism, in difficult cases. If this proves unsuccessful, the hot bath must be resorted to; and after faintness has been induced, the catheter may be again employed while the patient is still in the bath.

Further treatment, if necessary, must depend upon the condition of the patient. Generally, opium should be given by enema and by mouth, after which the catheter is again to be used. Ether is of great value in obstinate retention, in relaxing the muscles; preventing involuntary resistance and straining, and enabling the surgeon to use the catheter in more advantageous circumstances. The time which is to be devoted to the employment of all these means must be regulated by the judgment of the surgeon; but if still unsuccessful, and the patient's condition is urgent, the next step is to afford relief by making an artificial opening either into the bladder or the urethra.

To effect this, the following operations are employed:—

The stricture may be 'forced;' or the urethra may be opened at or behind the stricture; and the bladder may be punctured, either by the rectum, above the pubes, or through the pubic symphysis.

1. The first method, or 'forcing' a stricture, is rarely performed now with deliberate intention. It consists in driving a silver catheter of moderate size forcibly through the obstacles which oppose its course, in the direction of the bladder, which when reached is evacuated, and the instrument tied in. But this proceeding, although formerly recognised as admissible, must now be considered outside the domain of legitimate surgery.

2. The urethra may be opened, first, by a dissection from the surface through the stricture, according to the method already described as perinæal section (p. 223); secondly, the urethra may be opened behind the stricture, the bladder relieved, and the obstruction divided subsequently. Both these are delicate operations. Especially when the perinæum is indurated, it is by no means always possible to dissect through the stricture from the front, or to hit the urethra behind the obstruction. The

perineal section, under such circumstances, may fail to trace the narrowed channel, or even to discover the urethra; and a prolonged operation may then sometimes end in failure to relieve the patient.

The method of opening the urethra by an incision made altogether behind the stricture was recommended in this country by Guthrie and Liston, but is very rarely performed, the puncture of the bladder per rectum being now generally preferred. They advised introducing the left forefinger into the rectum, to distinguish the apex of the prostate, and entering a straight sharp-pointed bistoury with the right hand just in front of the anus, so as to hit upon the urethra at the point indicated by the finger in the rectum. The knife is carried upwards exactly in the median line, so as to make an incision of one or two inches in length. In this manner the urethra is to be sought, and the stricture afterwards divided forwards or not, as the operator determines to be most desirable.

3. The bladder may be punctured in two principal ways, viz. by the rectum, and above the pubes; to which has been added a third, through the pubic symphysis. Formerly it was also punctured by a direct stab from the perinæum—a dangerous proceeding, now wholly obsolete.

Puncture by the rectum is the operation most commonly adopted at the present day. Its results were carefully studied by Mr. Cock, formerly of Guy's, who did much to establish its value. It is fraught with less danger, and is more easy of performance, than any other which is adopted for the relief of retention. The objections made to it were: liability to abscess between the rectum and the bladder; a persistent fistulous opening there; injury to the seminal vesicles, leading to suppurative of the testicle; and the danger of perforating the peritonæum with the trocar. The last-named and most serious of these accidents is happily that which is most easily avoided. The puncture, made with care and judgment, usually falls short of the peritonæal pouch by an inch at least. The other results do occasionally, but only rarely, occur.

The operation is thus performed: The rectum being emptied by an enema, the patient is placed in the position for lithotomy, and firmly held by two assistants. The operator then introduces the left forefinger, oiled, into the rectum, and defines the posterior margin of the prostate, beyond which the finger should be extended if possible. Fluctuation should be obtained there, from the contents of the bladder, by a tap made on the hypogastric region, unless the viscus be very contracted, in which case the propriety of operating is doubtful, since the trocar may fail to enter through want of sufficient distension. Having determined a spot at which fluctuation is distinct, and directed an assistant to place a hand on each side of the supra-pubic region to support the bladder, a well-curved trocar, seven inches long, is carried along the finger in the middle line to the part indicated, the handle depressed, and the point carried through the rectum and bladder, until it is felt free in the cavity of the latter. As the stylet is withdrawn the urine flows, and the cannula, or a flexible tube passed through it, retained by a bandage and tapes. The length of time it should remain will depend on the amenability of the stricture to treatment. If this yields, the urine will pass through the natural channel, and the opening in the rectum will readily close: there is no fear of a fistulous opening; for when the cannula has escaped by accident, it has been impossible to replace it, and a fresh puncture has been necessary. When fluctuation cannot be felt by rectum, or when the prostate is enormously enlarged, this operation, as a rule, is not to be employed.

Puncture of the bladder above the pubes is performed as follows: The patient being placed in a half-reclining position, and the pubes shaved, a vertical incision of the integument is made directly above the symphysis pubis, about an inch in length; this is to be carried downwards through the linea alba, so as just to admit the tip of the finger to reach the distended bladder. Meantime an assistant, standing behind the patient, places one of his hands on either side against the abdomen to steady the bladder. A straight or a slightly-curved trocar (if the latter, the convexity should be upwards) is then to be carried with a very little inclination downwards into the bladder. After the operation the cannula should be exchanged for a silver tube,

specially adapted to slide through it, secured by tapes and a T-bandage, which may remain a day or two, when the tube may be withdrawn, and a gum-elastic catheter worn in its place.

Dr. Dieulafoy's aspirator is a safe and admirable instrument in some cases for relieving retention. I have had occasion to use it once, as a far less serious procedure than any puncture, properly so called, could have been, when retention was urgent, and a single relief of the bladder would probably suffice, as it did in this instance. Next day I was able to pass the catheter, after which dilatation sufficed to overcome the stricture which had originally caused the retention.

A puncture through the symphysis pubis was proposed by Dr. J. M. Brander of Jersey, in 1825, and some successful cases have been recorded. He introduced a hydrocele trocar of medium size, with or without preliminary division of the skin, about the centre of the symphysis, and at right angles to the vertical axis of the body. Dr. Brander says, 'somewhat obliquely downwards and backwards towards the sacrum, a piece of flexible catheter is then to be introduced through the cannula,' and retained by a tape. I attempted to perform this operation on an old man many years ago, and could not penetrate the symphysis, although the trocar was strong and not large in calibre. With the improved methods of puncture above referred to, this mode should not be in future adopted, certainly not in the cases of elderly persons where the cartilage is very firm or ossified.

In considering these methods in reference to any case which requires operation, the first question to be considered is the following :—

Are the patient's powers and condition such as to compel us to prefer the simplest method of affording immediate relief, without regard to ulterior results? If so, unless the urethra can be felt in the perinæum distended with urine, which may sometimes be the case, especially if that region be not thickened or deformed, the rectal puncture of the bladder, supposing the prostate not to interfere, is generally the simplest method, as it affords instantaneous relief at the smallest possible expense to the patient's powers. But if it is probable that the cannula may be required for some time after the operation, I prefer the supra-pubic method, especially if the bladder is distended, as it is difficult to maintain a cannula in the rectum for more than a few days; whereas I have seen patients wearing with perfect comfort a tube, even for many years, above the symphysis pubis. Again, if distension of the urethra is perceived in the perinæum (but this is rare) a bistoury may be carried into it, and a female catheter introduced by its side before it is withdrawn; or if the powers of the patient are good, and the condition of the parts is natural, perineal section may be employed. Having relieved the bladder, we can make a careful attempt to divide the stricture, by introducing a fine probe from below upwards through the stricture, and passing a catheter into the bladder. If, however, induration and deformity of the perinæum exist, the crisis of retention is not a favourable time for adopting this proceeding.

The treatment of retention from hypertrophy of the prostate.—When retention occurs in these cases, it is due to local congestion or inflammation. Hypertrophy occurs only after middle life, and develops itself slowly; and when much obstruction exists, exposure to cold, or an excess in wine, or excitement, may produce total retention. Catheterism is then usually absolutely necessary; for although partial relief may be avoided by the measures which reduce inflammation, spasm, and pain, the bladder can rarely be emptied, except by an instrument. In nine cases out of ten, nothing passes so easily as the French *coudée* catheter, which has a special fitness for meeting the difficulty which an enlarged prostate presents to most other instruments. In events of its failings, the best catheter is the English gum of rather full size (say 9 or 10); one that has been kept on an over-curved stylet for a considerable time, in order to impart to it a permanent curve, which is essential to success in its employment; and renders it exceedingly valuable. But in the absence of such an one, and also in some cases where the prostate is unusually large, it is necessary to employ a silver prostatic catheter; which should be about No. 9 or 10; and from twelve to fourteen inches long from the rings to the end of its beak; and the curved

portion should comprise about a fourth to a third of a circle of from four and a half to five and a half inches in diameter.

In passing the ordinary prostatic catheter, any difficulty met with is usually at the neck of the bladder; and its point requires to be tilted up over the tumid prostate. On this account a beaked catheter—that is, one resembling in form a lithotrite—will sometimes pass readily when the former fails.

The question occasionally arises, Is it desirable to evacuate the bladder completely when retention has existed for a long time? In very rare instances the removal of a large quantity of urine, amounting to several pints, especially when an upright position of the patient has been incautiously permitted, has been followed by fainting and depression, from which he has never rallied. When vesical dulness is very considerable, it is prudent to afford gradual relief. The removal of forty ounces will afford complete ease, the catheter is retained, and after the lapse of half an hour another portion may be withdrawn; in this manner the bladder may be gradually emptied, a condition which, as a rule, must be insured at least twice a day subsequently. It is not long since I gave evidence in a court of law, in a case in which death had occurred instantly after six pints of urine had been suddenly withdrawn in the upright position.

A point of importance remains. A catheter having been introduced with difficulty for the relief of retention, should it be permitted to remain? The answer must depend on circumstances. If the prostate and bladder are much inflamed the presence of a catheter may aggravate their condition. On the other hand, the bladder will soon fill again, and less hazard may be incurred by the presence of the instrument than by fresh attempts to pass it, especially if great difficulty was experienced in passing it at first. I have seen great danger incurred by the too early removal of a catheter which had relieved an urgent attack of retention.

If, however, which very rarely happens, catheterism proves unsuccessful, and relief is necessary, the bladder may be punctured (see page 230). If the prostate be very large, the rectum is not so convenient a situation for the proceeding as the supra-pubic region, which is therefore generally adopted. I have punctured by rectum with the best results for retention from enlarged prostate, but then a fluctuating point was within reach of the finger; this condition, however, is in advanced cases exceptional.

Perforation of the obstructing portion of the prostate was formerly a recognised proceeding, and was done by steadily pressing a strong silver catheter of full size, a finger having been placed in the rectum, through the obstructing tissues until the operator feels that the point is free in the bladder, and that the urine flows through the instrument. This was done by Home and Brodie. Liston employed a cutting stylet 'carried through a slightly-curved and long cannula,' and 'practised the operation a few times successfully.' I do not hesitate to disapprove of this proceeding, believing it to be always hazardous and in no circumstances necessary. Our present experience of puncture in various ways enables us to dispense with so uncertain and rude a practice as the foregoing.

Extravasation of urine takes place during unrelieved retention by the giving way of the urethra at some point; it is very rare indeed that the bladder itself is ruptured. In either case, however, mechanical distension is not the direct or only cause. Ulceration of the mucous membrane behind the stricture leads to a breach of the urethral walls. The bladder contracting drives the urine with great force into the cellular interspaces around, so that it soon reaches the superficial fascia of the scrotum and abdomen, when the rupture occurs anterior to the membranous portion, as is almost invariably the case. The situation of the swelling and inflammation is characteristic in these cases, because the course of the extravasated urine is defined and limited by the union of the superficial with the deep layers of fascia at certain points. Thus the scrotum is first distended; and, as the fluid increases, it rises into the coverings of the penis and over the pubes and abdomen, but does not descend to the thighs, because in the line of Poupart's ligament these fasciæ are blended, and prevent

the passage of urine beyond their junction. The consequences of extravasation are extremely disastrous; inflammation results from the irritating fluid wherever it goes, and the areolar connections of the skin and subjacent tissues are destroyed. If unrelieved, the distension becomes enormous, the scrotum sometimes attaining the size of a human head; the skin assumes a dusky red hue, or becomes purplish and livid; and gangrenous spots may appear; such an one is often seen on the dorsum of the penis, an unfavourable sign, although not one that is necessarily fatal. The general condition of the system is one of depression; and unless complete relief be afforded, the patient must inevitably be lost. He is frequently delirious, with brown tongue and extremely feeble pulse, when the extravasation is considerable.

In these circumstances it is necessary at once to make free and depending incisions into the distended parts. The scrotum especially demands a long and deep incision on either side the middle line, frequently the pubes, and the penis itself also. These incisions will not only free the parts from the extravasated urine, but provide for its passage from the bladder. By these openings the purulent matters, débris, and sloughs will subsequently come away, often in very large quantity. No immediate measures for the cure of the stricture are necessary, as in the patient's condition they are neither practicable nor advisable; and it is probable that when the retention is relieved a catheter may be passed into the bladder by the urethra; however, there is no occasion to do this until the system has rallied, which it often does to a marvellous extent. In a few hours the sufferer may emerge from a state of utter prostration to one of comparative comfort and promise; the symptoms of depression and exhaustion sometimes disappearing as by a charm, unless the injury inflicted has been too extensive to admit of repair. Meantime, alcoholic stimulant and nutriment may be given to support the powers of life. Ammonia and bark may also be serviceable. Opiates are rarely necessary, unless symptoms of nervous excitement appear.

However favourably the patient progresses, much sloughing takes place affecting the scrotum to a greater or less extent: both testicles are sometimes uncovered, and are even seen hanging by the cord. During this process the removal of the products of decomposition and the cleanliness of the parts must be provided for: poultices containing a little carbolie acid should be frequently applied and changed.

If the extravasation have taken place between the two layers of the deep perineal fascia, a firm, hard, and deep-seated swelling may sometimes, but not always, be detected in the perinæum and should at once be freely opened. If it occur behind the fascia altogether—but this is very rare—the urine finds its way upwards around the base of the bladder, and a fatal result is inevitable.

Rupture of the bladder.—This accident is excessively rare except as the result of direct violence. It then usually occurs from a blow on the abdomen or from a fall, when the viscus is distended with urine. It may be occasioned by a fragment of bone when the pelvis is fractured (see INJURIES OF THE PELVIS, vol. i.). When it happens as a sequence to stricture, it does so by ulceration, although it may not always occur in the bladder proper, but in a dilated sacculus springing from it. Occasionally the discharge of urine takes place directly into the peritoneal cavity, more commonly into the cellular connections of the organ below the line of its peritoneal coat, after which it may enter the peritonæum or not. In any case a recovery has never been known to happen, and can scarcely be regarded as possible.

The symptoms of vesical rupture take place after a prolonged but not necessarily absolute retention. The patient usually states that he has felt something give way. Acute abdominal pain then sets in; the belly becomes exceedingly tender and distended; the features are pinched and anxious; the breathing hurried; obstinate hiccough occurs, sometimes vomiting; the pulse is quick, and irregular; the flow of urine ceases altogether, as does also the straining to void it. General fluctuation may be sometimes found in the abdomen, and inordinate distension of the bladder, previously felt in the rectum beyond the prostate, has disappeared. Sometimes the patient is delirious, and even maniacal. And after a period varying from thirty-six

hours to four or five days from the accident, during which the patient's agonies are extreme, death takes place.

The indications of treatment are as follows : To provide for the free exit of the urine from the bladder by puncture ; to alleviate suffering by large doses of opium, with hot fomentations and rubefacients to the abdomen ; and to support the powers of life. Whether an attempt to remove the urine in case of extravasation into the abdominal cavity, by puncture of its walls, should ever be entertained, is an unsolved question. Such a proceeding affords the only chance (exceedingly slender as it is) of recovery which surgical aid could afford.

HENRY THOMPSON.

URINARY DEPOSITS.

OF all the ailments to which the human frame is liable, that of the formation of a stone or calculus in the kidney, bladder, or urinary passages is undoubtedly one of the most formidable and important. And on account of the tendency of this formation to become lodged in certain dilated portions of the urinary apparatus behind natural necessary narrowings, it is thereby rendered liable to increase in size, and consequently soon to become impassable and incapable of expulsion. The stone now acts as a foreign body, and irritates the delicate structure of the part in which it is retained, causing at first local disturbance and mischief, afterwards seriously involving the constitution, and ultimately leading to a miserable existence, which most frequently terminates in a lingering death.

In order to comprehend more fully the subject in all its bearings, it behoves us to take into consideration the causes and formation of stone; and in doing so, we must necessarily review cursorily the circumstances which may give rise to this affection by passing in survey the more simple and slight deviations of the urinary fluid, then its more aggravated changes from the condition of health, until we arrive at those still more complex and dangerous forms which cause the amalgamation of the deposits into a mass, constituting a stone.

But, previous to these inquiries, it is the essential duty of the surgeon to be well acquainted with the urine in a state of health, and in its varied conditions under every circumstance. He should know its chemical constitution, its specific gravity, its amount of acidity, its variety of colour, its microscopical appearances, &c.; and not only this, but he must also bear in mind the changes which the urine undergoes during certain conditions of the body, and during certain periods of the day: thus there is the urine of the blood, passed early in the morning before any repast; the urine after the use of drinks; and the urine after the partaking of solids—all modifying the condition of the constituents. All these points are carefully detailed in our standard chemical and physiological works, and in the numerous special monographs on the urine, to which the reader is referred.

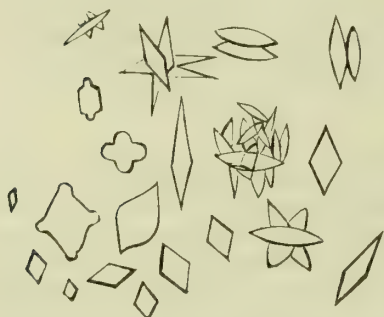
In making a careful analysis of the constituents of the urine, we find that there are two sources from which an abnormal condition may arise; and that an excess or deficiency of the elements from either of these sources may disturb the balance, and thus dispose to a precipitation of one or other of the constituents, causing deposits. The one source is from the organic elements, and of these urea and uric acid are the most frequent. Urea bears the proportion of twelve or fifteen to thirty or forty parts in 1000 parts of urine; it is exceedingly soluble and liable to decomposition with a development of ammonia, which is accelerated by mucus or other animal substances becoming putrid; this may take place in the urine in the bladder under certain diseased actions, and prove an abundant source for calculus. Uric acid, on the contrary, exists in very small proportions—half a gr. to one gr. in 1000 grs. of urine; it is very insoluble in water, so that any excess of living, such as increased animal diet, will cause a ready deposition of this substance; hence the frequency of deposits and calculi of uric acid; and from this being the chief constituent of most stones, the deposit has derived the name of lithic acid. The other source is from the inorganic constituents, the salts of the urine: these comprise saline and mineral ingredients. The saline are soluble in water, and consist of sulphuric, phosphoric, and hydrochloric acids, in combination with their bases, potash and soda. The mineral salts are insoluble in water, and consist of phosphoric and occasionally carbonic acids, in

combination with their bases, lime, magnesia, and sometimes alumina ; traces of silica are occasionally met with. Of these salts the phosphates are the most important, as being more readily prone to be deposited.

*Urinary deposits.*¹—These may be advantageously arranged under the foregoing two chief heads : (1) the uric acid and urate deposits, with their allies the oxalate, uric oxide, and cystic oxide varieties, derived from the organic or animal elements of the urine ; and (2) the phosphates and the carbonate of lime, deposited from the inorganic elements or salts of the urine. But besides these two varieties there are other deposits to which we shall merely direct attention, without entering into a description of them, viz. the non crystalline organic products, such as blood, pus, mucus, epithelium, spermatozoa, milk, fatty matter, &c.; and the high-coloured deposits of doubtful origin, viz. cyanourine, melanourine, indigo, Prussian-blue. Two rare forms of deposit, the fibrinous and uro-stealth, will be alluded to under the head of calculi.

1. The *uric acid deposits* may be simply a yellow-pink, red, or lateritious sediment, composed of variously-formed crystals : these crystals, however, may collect into uniform masses, producing a kind of sand, of about one-fortieth to one-sixtieth of an inch in diameter, and mostly globular or oblong ; again, such masses may concrete and form a diminutive kind of calculus, called gravel, attaining often the

FIG. 45.—Uric Acid.



size of a pea, and capable of being passed with the urine. The crystals very commonly consist of rhombic plates, with the obtuse angles more or less rounded off, or acuminate doubly-convex lozenge-shaped plates ; but the normal form is the rhombic prism. By the addition of acetic, nitric, or hydrochloric acid, uric acid may be separated from its salts in the form of rhombic tablets or six-sided prisms. Dr. E. A. Sansom² states that the form of the crystal is much affected by the strength of the acid which is added ; thus, where the acid is small in quantity, the crystals are regular, mostly tables, squares, and lozenges ; where the acid is in

larger quantity, added to a strong solution of urate of ammonia, they consist of large and long tables, with very elongated lozenges ; and where the acid is strong, and amorphous urate itself used, the crystals most frequent are acicular prisms. The causes which give rise to this deposit are described by Dr. G. Bird³ to be : (1) the waste of tissues being more rapid than the supply, as in fever, rheumatism, &c. ; (2) the supply of nitrogen in the food being greater than is required for the reparation of the tissues, as in over-indulgence, especially in the use of animal food ; (3) the process of digestion being insufficient to assimilate an ordinary and normal supply of food, as in dyspepsia ; (4) obstruction to the cutaneous outlet for nitrogenised secretions, as met with in diseases of the skin, variability of the climate, &c. ; (5) congestion of the kidneys, following injury or disease of the organ. Imperfect respiration is also said to be a cause of an undue proportion of uric acid in the urine, owing to an excess of carbon and oxygen uniting with urea. The treatment to be adopted will of course be to control and remedy the cause by abstinence from over-indulgence in animal food, regular diet, exercise, free action on the skin by baths and moderate diaphoretics, mild diuretics, diluents, liberal use of good water, and so on.

2. The *urates*, generally known as the urates of ammonia, form the most frequent urinary deposits. Heintz⁴ regarded these deposits as consisting of urate of soda and

¹ In giving a description of urinary deposits and urinary calculi, the author has availed himself of the standard works : for more minute detail reference must be made to the works of Bird, Beale, Thudichum, Bence Jones, the Catalogue of Calculi of R.C.S. England, Hassall, &c.

² Beale, *On the Urine*, p. 293.

³ *On Urinary Deposits*, 5th edit. p. 159.

⁴ *Lehrbuch der Zoochemie*.

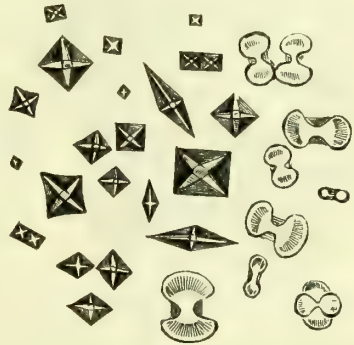
urate of ammonia, with traces of urates of lime and magnesia. Their colour is a pale fawn, but it may vary from snow white, through every tint, to brick-red, pink, or purple. Dr. Bird remarks, that in the white, fawn, or brick-red deposit there is a deficient state of the cutaneous functions; whilst in the pink, crimson, or purple variety there is more or less evidence of functional or organic derangement of the liver, spleen, or other organs influenced by the portal circulation, which is attributed by some to the presence of purpurine, and by others to the obstructed elimination of carbon, as in rheumatism, gout, and diseases of the liver or spleen. The alkaline urates generally form an amorphous deposit of minute spheres, having protruding therefrom acicular spiculæ of sharp crystals of uric acid. Some describe two forms of fawn-coloured deposit of urate of ammonia: the one, in which the precipitate mixes readily with the supernatant fluid by slight agitation, appears to form a very homogeneous mixture, and subsides exceedingly slowly by repose; the other, with frequent admixture of crystals of pure uric acid forming a pale urine, with diffusion of the deposit through the fluid in detached bran-like particles, which readily subside, and occasionally form dense clouds in the fluid, like puriform mucus, disappearing on heating; the urine is of low specific gravity. Sometimes the deposit becomes quite white, and often assumes a mucilaginous or jelly-like character.

The causes and treatment are, for the most part, those of the uric acid deposit. Open air, healthy residence, and tonics, either mineral or vegetable, are essential.

FIG. 46.—Urate of Ammonia.



FIG. 47.—Oxalate of Lime.



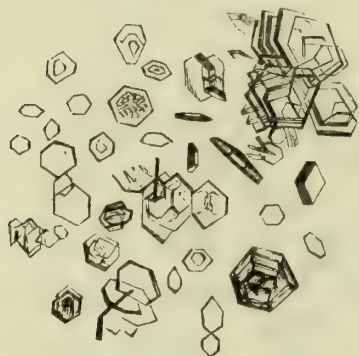
3. Closely related to uric acid are two bodies, xanthine and hypoxanthine, containing respectively one and two atoms less oxygen. The deposits, indifferently called *uric oxide*, *xanthic oxide*, or *xanthine*, consist of the latter of these two bodies. It is probable that the conditions under which it is deposited depend upon an imperfect oxidation of the materials from which uric acid, containing two atoms or nearly 17 per cent. more oxygen, is normally eliminated by the kidney.

4. The *oxalates* are usually observed in the form of oxalate of lime, the crystals consisting of two varieties. One of these is the quadratic octahedron class, which generally have one axis much shorter than the other two. Their varieties in shape are due to the position in which they are viewed, some even being flattened and square, and resembling the back of a letter envelope. The other variety is the dumb-bell shaped crystal: this is considered by many to be formed by oxalurate of lime, and by others to consist of uric acid, both of which fallacies are explained in Dr. Beale's work, pp. 300 *et seq.* The dumb-bell crystals often unite into a mass, and form the nucleus of a concretion called the hemp-seed calculus. Dr. G. Bird considered these deposits to be due to an increased oxidation of the uric acid formation, and believed that they never exist in healthy urine, although their constituents are present under one form or another. Lime is always present in the urine, combined with phosphoric and perhaps other acids; and so great is the insolubility of the oxalate of lime, that the addition of oxalic acid as a soluble oxalate instantly

determines the precipitation of the salt. The particular manner in which the evolution of the oxalic acid found in the urine occurs can scarcely be regarded as at all satisfactorily explained; most, however, seem to regard it as a secondary product of the oxidation of the saccharine matter occasionally present in the secretions, and thus appear inclined to draw a close analogy between the diathesis in which sugar and that in which oxalic acid is generated. Dr. Prout maintained that oxalic acid is one of the results of imperfect digestion, and that it is derived from vegetable food, more especially such as contains sugar. Liebig taught that it arises from the imperfect oxidation of uric acid during the metamorphosis of the living tissues;¹ if the supply of oxygen fails to a certain extent, the products of combustion in the lungs are urea, oxalic acid, and the substance called allantoin. Dr. Owen Rees² considers that the oxalate of lime concretion is formed by the decomposition of uric acid, or of an urate in the kidneys or bladder; these are converted into oxalic acid, which unites with the lime, so that the oxalitic diathesis is an accidental and unimportant modification of the uric acid diathesis.

The causes of this condition have been attributed to great nervous depression, as from grief, loss of blood, malaria; and of course the treatment will be to counteract these causes, and to pay great attention to diet and the action of the skin; as also to avoid all articles containing or liable to produce sugar, as fruits, fermenting liquors, and substances into which oxalic acid enters as a constituent; mineral acids are highly beneficial.

FIG. 48.—Cystic Oxide.



5. The *cystic oxide* deposit, or cystine,³ is described to be bulky and easily diffusible, resembling in appearance the white or pale lithates, and to consist of more or less distinct six-sided plates, variously super-imposed one upon the other, the centre portion of the crystals being somewhat opaque. Dr. G. Bird believed that it does not exist in healthy urine, and rarely in morbid; but is probably derived from the sulphur extractive matter of the urine; and he inferred that it proceeds from the waste of tissues and of the hæmato-globuline. In the majority of the sufferers the general health and

nutrition have been bad. The indications for treatment are acids and tonics; such as nitro-hydrochloric acid, chalybeates, &c.

We now come to the deposits, for the most part of inorganic origin:—

6. The *phosphatic* deposits. The phosphatic salts in healthy urine are of two kinds—the alkaline and the earthy phosphates. The alkaline includes the phosphate of soda, the acid phosphate of soda, and the phosphates of soda and ammonia, which are perfectly soluble, and do not give rise to deposits or concretions. The earthy phosphates—viz. phosphate of lime and magnesia—occur in very small quantities, and are eliminated in a perfect state of solution, but under certain circumstances and certain morbid actions are readily deposited and form concretions. These earthy phosphates are insoluble in water, but are dissolved by mineral acids; they are soluble in organic acids; albuminous substances dissolve them, but the salts are again readily precipitated by ammonia. Thus the phosphatic deposits are derived from the earthy phosphates of the urine, and comprise three varieties:—

1st. The *phosphate of lime*. The deposits of this salt, Dr. Bird observes, have led to more errors than any other class. Where it exists in the urine in solution, or is precipitable by heat, it has repeatedly been mistaken for albumen; and where it has formed the great mass of a deposit, has as frequently been mistaken for pus or

¹ See Liebig's *Annalen*, lxxxii. 231.

² *Croonian Lectures*, London, 1856.

³ On the chemical relations of uric acid, see Odling's *Lectures on Animal Chemistry*, 1866.

purulent mucus. The deposits consist generally of a white amorphous matter, not in crystals, but as minute granules; after standing for some days, little spherules are very frequently found. Dr. Beale says that this phosphate may also assume the form of minute dumb-bells; an appearance probably due to the adhesion of two little spherules, which afterwards became coated with a fresh deposit of the phosphate. Dr. Hassall, in the 'Trans. Roy. Soc.,' January 1860, where he gives a detailed account of it, states that it is more frequently found in a crystalline form in the urine than in an amorphous character. He describes the crystals as either single or aggregated, forming glomeruli or rosettes; and the more perfect crystals as having an oblique, six-sided, prismatic form.¹ 2nd. The deposits of *ammonio-phosphate of magnesia* (the triple phosphate of magnesia and ammonia) generally assume the form of crystals of triangular prisms with truncated extremities, the terminal edges of which are sometimes bevelled off; or of four-sided prisms and irregular six-sided plates; or again, of stellate crystals, when ammonia has been added to the urine. The urine in this variety is often of a natural colour, of rather high specific gravity, and is sometimes neutral, often acid and seldom alkaline; it evolves a pungent, disagreeable, and even fetid odour, which has been usually, but erroneously, denominated ammoniacal. 3rd. The deposits consisting of a combination of the

FIG. 49.—Phosphate of Lime.

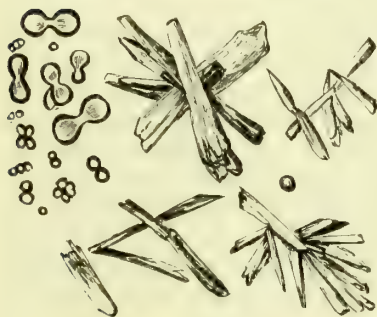
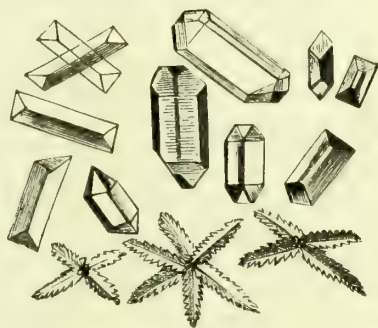


FIG. 50.—Triple Phosphate.



two foregoing, viz. the *phosphate of lime* and *triple phosphate*, which is also called the *mixed or fusible* variety of phosphates.

The causes of phosphatic deposits are generally considered to be an alkaline state of the urine, from a diminution of the requisite acidity; this alkaline condition being due to local disease, injury of the urinary organs, the presence of foreign bodies, or to general morbid conditions, such as over-exertion, vital depression, spinal disease, insufficient food, or abuse of alkalies and medicines. The source of this alkali may be an excess of carbonate of ammonia, probably effected through the medium of a ferment converting the urea into this salt. Again, mucus altered by an unhealthy condition of the mucous membrane may effect the conversion of urea into carbonate of ammonia; so may also the presence of a fixed alkali, such as the phosphate of soda, produced during digestion. Dr. G. O. Rees maintains that the alkali which causes the precipitation of the phosphate is secreted by the mucous membrane of the bladder; the earthy salts are precipitated from the urine, and not secreted from the mucous membrane, as was formerly supposed. The treatment of such deposits will be the removal of all recognisable causes, such as imperfect digestion and assimilation, improving the patient's powers, and correcting the morbid conditions of the kidneys and mucous membrane of the bladder.

7. The *carbonate of lime* deposits are of rare existence, generally of secondary formation, and usually occurring in an amorphous form. Under the microscope they appear as small and delicate crystalline spherules. These often congregate together, and assume the shape of a drum-stick. The deposit is stated to be the result of

¹ Hassall, *Urine in Health and Disease*, 2nd edit. p. 212.

such a state of enervation, that the bond of affinity, which in a healthy condition of the nervous system keeps firmly united the elements of urea, becomes loosened; a rearrangement of atoms occurs, the urea becomes carbonate of ammonia, and, under the influence of ordinary chemical affinity, carbonate of lime is generated at the expense of the calcareous salts of the urine.¹

Having thus taken a cursory survey of the formation of deposits due to changes in the urinary fluid, we now pass on to the more aggravated conditions, viz. the amalgamation or concretion of such deposits into a mass, forming a stone or calculus. The formation of a calculus, in a practical point of view, may be attributed to one of three causes: 1st, it may take place in the secreting cells of the kidney, by precipitation of the salts, such as occurs naturally in the kidneys of reptiles and birds; 2nd, it may form in the bladder itself without renal origin, from immediate primary precipitation, in consequence of stagnation of urine in the bladder or otherwise; and 3rd, it may be produced by the presence of a foreign body in the bladder, whether introduced from without, or existing within in the shape of coagula of blood, fibrin, &c., which leads to abundant precipitation.

When once solid particles of any substance aggregate and form a mass in the bladder, they very readily induce crystallisation of uric acid, oxalate of lime, or triple-phosphate; or a deposition of urate of ammonia, phosphate of lime or other amorphous ingredients, according to the lesion of function, the state of irritability or innervation present, and the condition of the bladder.

The simplest mode of witnessing the early formation of a stone is in cases where a gum elastic catheter has been allowed to remain in the bladder for some time, when, on its removal, urinary crystals and deposits are found encrusted upon it. Foreign bodies, no matter of what nature, when present in the bladder, cause decomposition of the urine, and a ready deposition of its salts upon it. Solid substances irritate and inflame the mucous membrane of the bladder, and this, as Dr. Rees² observes, causes the latter to secrete a quantity of alkaline fluid, which comes in contact with the earthy phosphates, and is precipitated around the foreign body. Soft substances, on the contrary, such as mucus, fibrin, &c., do not irritate the mucous coat, but cause a precipitation of the ordinary salts of the urine around them, viz. the uric acid, urates and oxalates, and thus form stone.

Another, and by far the most frequent, cause in the formation of a vesical calculus is the escape from the kidney of a stone, which cannot pass with the urine through the urethra, and which acts in fact as a foreign body, and receives depositions on its surface. Renal calculi³ are for the most part composed of uric acid or urate of ammonia, less frequently of oxalate of lime, rarely of triple-phosphate of ammonia and magnesia, and, in some cases of diseased kidney, of phosphate of lime. If an excess of uric acid be separated by the kidneys, crystals of uric acid are thrown down; the latter may also be derived from decomposition of the urate of ammonia—the more ordinary source.

The oxalate of lime calculus of the kidney, according to Dr. Prout's researches, is not generated in a perfectly healthy kidney, and two conditions are necessary to its formation: the first that the oxalic acid should exist in the system, and be secreted with the urine; the second, that lime, in some shape or another (that is, the phosphate or carbonate), shall be furnished by the mucous membrane of the infundibulum. The triple-phosphate of ammonia and magnesia is rarely deposited in the kidney, but it may form a coating for the other calculi, if lodged for a considerable time in the organ. Its formation, according to Dr. Prout, takes place in the following manner: the urine, under ordinary circumstances, contains the phosphate of magnesia, which is held in solution, being a highly soluble salt. But in some cases of disease the urea of the urine becomes decomposed in the kidneys, and ammonia is evolved, which combines with the phosphate of magnesia so as to make the triple salt.

¹ *Guy's Hosp. Reports*, series i. vol. vii. p. 224.

² *Croonian Lectures*, p. 23.

³ Brodie, *On the Urinary Organs*, p. 223.

Dr. Beale¹ observes: 'It is not uncommon to meet with microscopic uric-acid calculi; aggregations consisting of uric acid crystals, which if retained might receive deposits of fresh material on the outside, until small calculi, varying in size from a mustard-seed to that of a pea, or larger, are formed. Microscopic calculi of phosphate of lime are by no means uncommon, and are often found in the kidney; but until a few years ago I had never had an opportunity of watching the formation of calculi composed of oxalate of lime. The nucleus of these calculi does not consist of mucus or epithelium, as in the phosphatic, but is of the same composition as the exterior.'

The formation of a calculus in the bladder without any previous nucleus of renal origin, or the presence of a foreign body, is due either to an excess of insoluble material and the immediate precipitation of the salts of the urine—as in the ordinary forms of uric acid, urate, and oxalate concretions—or to stagnation of the urine in the bladder, in consequence of paralysis, hypertrophy, chronic inflammation, and catarrh of the organ, as well as diseased prostate and urethra.

Von Walther² maintains that lithogenesis is to be considered as a medium between chemical crystallisation and organic growth, and that it has always a greater disposition towards the latter. Wetzlar³ does not consider that animal gluten is necessary for the production of stone; that urinary calculi are in no respect organic bodies. Some erroneously attribute their formation to fermentation.

The whole of the chemical constituents of a stone require to be held together by a kind of cement, which is believed to be derived from animal matter, either mucus, fibrin, or fatty matter; and some affirm that it may be blood, epithelial scales, or even pus. Mr. Coulson (in his work on 'Diseases of the Bladder,' p. 343) thus sums up: Marcet referred it to the mucous secretion of the bladder; Fourcroy and Vauquelin to albumen, and sometimes to gelatine with an admixture of urea; Berzelius, however, could not determine whether it was composed of fibrin, albumen, gaseous matter, or mucus; Brande considered it to consist of a mixture of gelatine with urea; Scharling holds 'that the smaller calculi are always enveloped by a layer of mucus, albumen, or some other organic matter, the flocculi of which entangle, and ultimately determine, the crystallisation of the more insoluble ingredients of the urine;' and Dr. Hoskins, as quoted by Gross, extends this view to the minutest particles of the concretion; he found that the pellicle of transparent animal matter enveloping the particles, when completely divested of salts, bore a great resemblance to epithelial scales; he also frequently detected in the central parts of calculi a large proportion of epithelial scales from the bladder and kidney, with fibrinous casts from the uriniferous tubes.⁴

Urinary calculi may be arranged, like the deposits, into two distinct classes, to which a third may be added comprising the rarer forms. The first will include calculi of uric acid and the urates, with their modifications, the oxalates, uric oxide, and cystic oxide; the second, the phosphatic calculi, embracing all the varieties of phosphates; the third will consist of the rare calculi of carbonate of lime, the fibrinous and the silicious formations. Although these constitute the essential elements of calculi, yet there are other chemical ingredients present in more or less quantities; such as organic matters, carbonate of magnesia, silica, oxide of iron, benzoate of ammonia, oxalate of ammonia, phosphate of iron, urea, clay-mica, &c.

The number of urinary calculi present varies; the renal are generally two or more, the vesical usually only one, and the prostatic very numerous: the vesical, however, may amount to 117, 242, 307, 678, and even to 1000, as stated by Dr. Physick.⁵

The size also is extremely variable, viz. from that of a pea, nut, or almond, to a cricket-ball; the phosphatic calculi usually attain the largest size.

The weight depends not so much upon the size as the composition of the stone,

¹ *On Urinary Deposits*, 2nd ed. p. 392.

² *Journal für Chirurgie*, vol. i.

³ *Beiträge zu Kenntniss des menschlichen Harnes*, 1821.

⁴ See also Dr. H. V. Carter, *Structure of Calculi* (London, 1873), and Dr. Ord, 'Urinary Crystals and Calculi,' *Med.-Chir. Trans.* 1875, p. 165.

⁵ *Gibson's Institutes*, 5th ed. vol. i. p. 220.

for the phosphatic are very light, and the oxalates very heavy; it may vary from a few grains to many ounces. The majority are under an ounce; the heaviest on record was 6 lbs. 3 ozs.¹ Recent calculi are denser than old, as containing moisture.

The shape is not uniform, depending greatly upon the situation and composition of the stone; thus renal calculi are irregular, and often moulded to the form of the calyces, pelvis, and infundibulum of the kidney; those in the ureter are generally cylindrical; the vesical are more regular and of an ovoid form; the prostatic numerous, small and faceted, or pea-shaped. Again, uric acid and urate of ammonia calculi are generally smooth and regular; the oxalates tuberculated like a mulberry, hence the latter appellation; the phosphates irregular and contorted. But there is an infinite variety of forms, such as conical, pyramidal, triangular, cubical, square, rhomboidal, reniform, pisiform, cardiform, cuneiform, semilunar, &c. Some appear as if they had been actually divided by a firm cutting instrument; and in one case, in the Guy's Museum (No. 2136⁵⁰), the apparently divided portions seem as if they had again become cemented and framed in by a subsequent deposit. In the same collection (No. 2145³⁵) there is a cystic oxide calculus in the shape of an eardrop. Some remarkable forms of calculi have been detailed in the Guy's Hospital Reports, series iii. vol. iii. p. 351, where the appearance resembles that of two calculi united by a transverse bar, from which circumstance they are termed barshot or dumb-bell shaped calculi; these forms are generally met with in calculi which have originated or become lodged in the prostate, and grown backwards into the bladder. Such shapes have also been found in encysted calculi of the bladder.

The colour of a calculus depends for the most part on the chemical nature of the crust or surface, but this by no means indicates the actual nature of the interior of a calculus: a white surface shows a phosphatic crust; a cinder-grey, that of urate of ammonia; a yellow, pale-brown, or brown, the uric acid; cinnamon-brown, the uric or xanthic oxide; a brown, brownish-green, or even blackish-green, the oxalate of lime; a grey-greenish hue, the cystic oxide. These colours, however, are liable to modification, and give but presumptive evidence.

The odour of recently extracted calculi is sometimes peculiar. The phosphatic calculi are very ammoniacal, fetid, and acrid; oxalate of lime calculi on section are said to emit a faint odour of semen. Some are affirmed to possess an aromatic smell, like that of castor or musk.

The consistence depends in a measure on the chemical composition, on the amount of cohesion of the particles, and on the presence of moisture or organic matter: it varies from that of soft mortar or sand to that of hard marble. Phosphatic calculi are generally soft, the uric acid hard, and the oxalate very hard. The crust is usually the softest part of a stone, and the nucleus the most dense. A stone of rapid formation is less dense than one of long existence and of small size.

The section of a calculus shows its internal construction, and ordinarily presents a centre or nucleus, a body or intermediate part, and a crust or outside coating. When all these consist of one and the same chemical material, the calculus is called uniform or simple; when it is made up of one or more elements, the stone is termed mixed, heterogeneous, or compound. Again, these elements may be so disposed as to form a solid mass, without any visible distinction of arrangement; but generally they are deposited in concentric layers or laminae, and in some instances there are seen lines radiating from the centre to the circumference, as if the laminae were composed of perpendicular crystalline fibres. Dr. Prout² thus explains the laminated condition: 'Between the different intervals at which the different laminae have been formed, periods have intervened during which no deposition has taken place. This remark not only applies to the different laminae of a heterogeneous calculus, but to the different laminae of calculi composed of the same substance; as, for instance, to the different laminae of which lithic acid concretions usually consist. This explanation is in perfect accordance with the circumstances attending the formation of

¹ Coulson, *op. cit.* 5th ed. p. 337.

² Prout, *On Gravel, Calculus, &c.*, p. 361.

calculi, which often, as is well known, remain in the bladder for a great number of years without attaining any remarkable size. Moreover, the constant state of change alone, to which the urine in all individuals is liable, almost precludes the notion of homogeneity in a calculus. We may suppose, therefore, that certain changes take place in the urine during which the law of continuity of deposition is suspended, and the surface of the concretion becomes, as it were, *water-eaten*, and less apt for future accretion; in short, assumes all the properties of a heterogeneous substance. Under these circumstances, when a tendency to deposition occurs, it will have to commence *de novo*, and, as it were, on the surface of a foreign body. The consequence will be, that the adhesion between the new and the old coats or laminae will be less firm than in the intermediate parts, and that a calculus thus formed will be disposed, when broken, to separate into concentric laminae.'

Dr. Hodgkin¹ gives the following account of the *Structure and Character of Calculi*:—

A. Calculi of a crystalline character.—In many instances, the particles separated or precipitated from the urine to form calculi, assume a crystalline character; and the mode in which this crystallisation takes place around a small nucleus materially influences the structural character and the form of a calculus. The structure is radiated, and the form more or less rounded. Such specimens of calculi bear considerable analogy to certain zoolites, and to some specimens of radiated quartz. The cystic oxide affords one of the best specimens of decidedly crystalline calculi. Some of the phosphates appear to come next; and calculi consisting of oxalate of lime frequently present evident traces of crystallisation.

B. Amorphous or massive calculi.—The molecules which unite in the composition of these calculi do not possess a perceptible crystalline form, and the resulting substance is what the mineralogists would call massive, with no other indication of structural arrangement than more or less distinct traces of superposition in concentric layers. There is considerable variety in calculi of this description; some possessing granular texture, which might be compared to a coarse sort of sandstone, whilst in others it is soft and earthy, like some of the softest specimens of chalk or tufa. The lamellar arrangement is very differently perceptible in different specimens; in some it is strongly marked, and the calculi, which are easily crushed, separate in shell-like flakes; whilst others, in which the arrangement is less conspicuous, break up almost indifferently in all directions.

C. Calculi intermediate between crystalline and amorphous.—These are such as present a mammillated surface, and on close inspection of a section or fracture appear to have their several lamellae made up of short fibres, at right angles to the plane of the lamellae. These are often an assemblage of acicular crystals. This form of calculus is most frequent in those specimens which are composed wholly or chiefly of oxalate of lime.

It is not unfrequent to meet with a model calculus, viz. the nucleus formed of uric acid or urates, as urea is the chief constituent of healthy urine; the body composed of oxalate of lime, which latter Dr. G. O. Rees regards as uric acid or urates altered after secretion, and lastly, the crust formed of phosphates, the result of irritation. When a calculus consists of different layers, one deposit succeeding another in a regular manner, it is called *alternating*.

For a careful analysis of the condition and relative proportion of the constituents of urinary calculi, as regards the nucleus, body, and crust, we must refer the reader to the standard works on urinary calculi, and more especially to the Catalogue of Calculi in the Museum of the Royal College of Surgeons of England, in which work also there are excellent coloured plates of all varieties of calculi. In general, calculi are classified according to the apparent nature of the nucleus; and for the present this nomenclature is adopted, although Dr. Beale² points out a fallacy when he states that it is important to bear in mind that the central part of the calculus which is visible to the unaided eye is spoken of as the nucleus, while the real nucleus may be microscopic, and of a different composition to the material which immediately surrounds it. The nucleus of many calculi, which apparently consists of uric acid, is really composed of oxalate of lime, around which the uric acid has been deposited.

¹ *Guy's Hospital Reports*, series i. vol. ii. pp. 268, *et seq.*

² *On Urine and Urinary Calculi*, 1861, p. 354.

The nucleus, according to Dr. G. Bird's¹ observations, is usually found in the geometric centre of the calculus, or nearly so; but it is occasionally remarkably eccentric, as in some reniform concretions; and in a few, several distinct nuclei, or centres of deposition, are met with. In some rare instances, the concretion which forms the nucleus is found loose within the body of the entire calculus; a circumstance, in all probability, arising from a layer of blood or mucus having concreted around the nucleus, and the matter forming the body of the calculus having been deposited on this layer. In this case, on the whole becoming dry, the mucus or blood would be diminished to a very thin film, and the calculus would appear to contain a loose nucleus. In a few instances calculi appear to possess no nucleus, the centre being occupied by a cavity full of stalactites or mammillated projections, giving the idea of the external layer having been first formed, and the mammillated portions subsequently in the interior. In the Museum of Guy's Hospital this state occurs only in the uric-acid calculi. The explanation of the formation of such cavities is, that the original nucleus was either blood or mucus, which has disappeared by desiccation.

Although in an essay of this kind we cannot enter fully into the chemical analysis of urinary calculi, yet we have deemed it advisable to introduce the following oft-quoted table of Dr. Bence Jones,² somewhat modified.

Urinary Calculi.

A. Destroyed by heat; combustible; leaving only a small residue:	
1. Become red on the addition of nitric acid, and form a murexide:	
a. Soluble in carbonate of potash, evolving <i>no</i> ammonia; soluble in caustic ammonia, or potash; on the addition of an excess of acid crystallises in angular crystals; not soluble in water . . .	Uric acid.
b. Soluble in carbonate of potash, evolving ammonia; soluble in water when boiled; solution in water with a few drops of ammonia, when evaporated, crystallises in needles	
2. Do not become red on the addition of nitric acid.	
a. Soluble in ammonia, <i>not</i> crystallising when evaporated; insoluble in carbonate of potash; dissolves without effervescing in nitric acid, leaving a lemon-coloured residue; soluble in strong sulphuric acid, not precipitated by dilution	Uric or xanthic oxide.
b. Soluble in ammonia, crystallising in six-sided plates when evaporated; soluble in strong caustic potash; the solution, when boiled for a few moments, on the addition of a drop of dilute acetate of lead, gives black sulphide of lead	
c. With difficulty soluble in ammonia, not crystallising; with nitric acid becomes bright yellow; solution in caustic potash precipitable by acetic acid in an amorphous form; emits an odour of burnt feathers or ignition	Fibrinous.
B. Not destroyed by heat; non-combustible; leaving a considerable residue:	
1. Soluble with hydrochloric acid; effervesces <i>before</i> heating; soluble in mineral acids with effervescence; solution in acid, when neutralised, gives a precipitate with carbonated alkalies and oxalate of ammonia; soluble in dilute acetic acid, with effervescence . . .	Carbonate of lime.
2. Soluble with hydrochloric acid; effervesces <i>after</i> heating; soluble in mineral acids without effervescence; insoluble in acetic acid; when boiled with carbonate of soda, oxalate of soda is found in the solution and is precipitated by chloride of calcium after acidifying with acetic acid.	
3. Soluble with hydrochloric acid; does <i>not</i> effervesce either <i>before</i> or <i>after</i> heating:	Oxalate of lime.
a. Solution in acid with excess of ammonia gives a white <i>crystalline</i> precipitate; with half its bulk of phosphate of lime (bone-earth) is very fusible before the blow-pipe, and gives off an ammoniacal odour; dissolves in acetic acid without effervescence	
b. Solution in acid with excess of ammonia gives an amorphous precipitate; with twice its bulk of phosphate of ammonia and magnesia is very fusible before the blow-pipe	Phosphate of ammonia and magnesia.
	Phosphate of lime.

¹ *Guy's Hospital Reports*, series i. vol. vii. p. 182.

² *Medical Times*, Oct. 1851.

c. Solution in acid with excess of ammonia gives a white, partly crystalline, partly amorphous, precipitate; without addition easily fusible before the blow-pipe	Mixed phosphates, Silica.
4. Not acted upon by acids or alkalis; fused with twice its bulk of carbonate of soda forms glass	

We will now give a general description of each variety of calculus.

1. The *uric-acid calculus* is the most frequent, and was discovered by Scheele in 1776. Calculi composed entirely of uric acid in the several collections bear the proportion to all other calculi as 1 to 4 and 5; and, as a nucleus in compound calculi, from 1 to $1\frac{1}{4}$ and $2\frac{1}{3}$. The colour is generally light brown, yellowish-brown, or brownish-red, but may vary from pale fawn to a rich brown, and may sometimes resemble old mahogany or polished oak; the surface may also be coated with a crust of amorphous urate of ammonia or phosphate of lime, giving a white appearance; and the nucleus, although consisting of pure uric acid according to Dr. G. O. Rees, may be quite white, owing to the absence of colouring matter. The size varies greatly, and it often attains considerable bulk: the specific gravity is intermediate between the oxalate and the phosphate; the form is generally ovoid, laterally compressed and smooth, but sometimes beset with small tubercles, which may be increased to such an extent as to make the stone resemble the oxalate of lime: the calculus may also mould itself into irregular shapes in the locality in which it may be placed. The appearance on section varies extremely; Dr. Thudichum² describes it to consist of concentric layers of variable thickness, every layer preserving its own thickness, pretty regularly all round the calculus; the texture is best seen on the surface; in the hard and pure varieties it is crystalline and fibrous, the fibres of each layer converging like radii towards the centre of the stone, and their fracture being almost parallel with those fibres; the less dense and pure calculi are of a more earthy character and amorphous in fracture, having no laminae. Some few are so hard as to impart a ringing noise on percussion, a sharp sound like a pebble. Here the fracture is conchoidal, and such stones, when broken, as in lithotomy, form sharp angular fragments, which are dangerous from their tendency to wound the bladder and urethra.

2. The *urate-of-ammonia calculus* is not common; it was discovered by Fourcroy and Vauquelin in 1798. In the Museum of the Royal College of Surgeons, Edinburgh, there are only 14 in 619 calculi, being 1 in 46; at Guy's Hospital Museum there are 7 in 394; but this substance forms an important constituent of compound calculi, varying from 1 in $3\frac{1}{4}$ to 1 in $7\frac{1}{2}$ of all calculi. The calculi are seldom large, rarely exceeding an inch in size, are generally ovoid and smooth, or sometimes lightly tuberculated on the surface. Their colour is very generally characteristic, being of a slate, pale greyish-fawn, or clay colour; not unfrequently they more nearly resemble pipe-clay in tint; sometimes there is an admixture of red or brown, and in rare instances pink layers are observed near the centre. In the Guy's Hospital Museum (No. 2213) there is a remarkable collection of 142 calculi removed from the bladder of one patient by Sir Astley Cooper, all of the same figure, being cubes rounded at the edges and angles; these have the colour of pipe-clay, and are chiefly composed of urate of ammonia: it is curious that the patient had afterwards another calculus, which on examination proved to be of a different kind from these. Their consistence is usually compact, earthy, and very brittle, and they have a fine earthy fracture; this is well shown in a calculus (Guy's, No. 2136⁵⁰), where there is a remarkable fissure running through it, as if it had been fractured and subsequently reframed by a deposit of urate of ammonia. They seldom present the distinct concentric arrangement of uric-acid calculi, generally appearing homogeneous, but at times an indistinct thin laminated condition may be traced; this circumstance is readily explained by the frequent amorphous condition in which the urate is deposited in sediments. These calculi are generally observed in children, and are said to give rise to little constitutional disturbance.

¹ See preparation No. 2125, Guy's Hospital Museum.

² Thudichum, *On Urinary Deposits, &c.* p. 111.

Calculi of urates of soda or lime are not met with ; the salts are generally mixed with those of urate of ammonia or uric acid in the several layers of compound calculi. In one instance, however (Guy's Hospital Museum, No. 2154³⁶), there is a fusible calculus with a nucleus of urate of lime.

3. *Uric oxide or xanthic oxide, or xanthine* (see *ante*, p. 237), discovered by Dr. Marcet in 1815, is a very rare calculus, of which only four specimens are recorded.

The calculus in which Dr. Marcet first detected this substance weighed but eight grains, and nothing is known regarding the portion not consumed in the analysis: it does not exist in the collection at Guy's Hospital, and neither Dr. Prout, Dr. Yelloly, nor Dr. Babington can give any information on this point. It was rediscovered by Dr. Stromeyer: ¹ the calculus was removed by Langenbeck from a peasant's child eight years of age, at Hanover. In shape it resembled a flattened pullet's egg: it broke into three pieces during the operation. The whole calculus weighed nearly 330 English grains; its section was partly of a lustrous bright brown colour, and partly earthy and pale brownish flesh colour. It was composed of concentric separable layers, without any appearance of a crystalline or fibrous texture: it possessed a distinct nucleus, which did not, however, differ in chemical characters from the body of the calculus. It was as hard as uric-acid calculi generally are, and on slight friction it assumed a wax-like lustre. Professor Merx of Göttingen sent two fragments of the calculus to Dr. Willis, one of which is in the Museum of the Royal College of Surgeons, Edinburgh, and the other is in the Guy's Hospital Museum (No 2145⁹⁰). In the Catalogue of Calculi at the College of Surgeons of England there is a plate of this calculus (see Plate xii.).

4. The *oxalate-of-lime calculus*, discovered by Wollaston in 1797, is the next most frequent after the uric-acid calculus, and bears the ratio of 1 in 14½ to 1 in 20 of other calculi. These calculi do not generally attain a very large size, but are very compact, dense, and proportionately heavy. As a nucleus in compound calculi, its proportion varies from 1 in 4¾ to 1 in 7½.

Dr. G. Bird ² thus describes these calculi: Their form or external configuration is almost invariably that of a tubercular, angular, or spinous character, and rarely perfectly smooth, which, together with their colour, varying from grey to a rich brown or almost black, has gained for them the specific name of 'mulberry.' In some calculi the surface is studded with spines so acute and slender as to resemble thorns; in others there is a coating of acute octahedrons of transparent oxalate of lime, giving an extremely beautiful appearance. Sometimes these crystals are opaque, and the octahedron is remarkably flattened: the calculus then looks as if studded with pearlspar.³ Sometimes these intervals between the projections or spines are filled up by some amorphous substance, as urates, or phosphates, thus giving the whole an ovoid character. The appearance on section is generally that of an imperfectly lamellated structure, the consecutive layers forming waving lines, and often resembling knotted heart of oak; occasionally there is seen a layer of oxalate of lime arranged round the interior one with great regularity, having a remarkably radiated appearance, like a series of infinitely minute needles placed side by side, and presenting a perfectly porcellaneous structure. In compound calculi the oxalate of lime deposition gives to the character of a stone a remarkably beautiful appearance resembling that of fortification agate.

The rarer varieties of oxalate-of-lime calculus are the following:—

1st. The small, smooth, globular 'hemp-seed calculus' described by Dr. Wollaston, and thus alluded to: 'It is of a much lighter colour, so as to resemble in hue as well as smoothness the surface of a hemp-seed.' There may be one or many, and they are generally found in the kidney.

2nd. Where the character of the calculus is crystalline throughout, and it has a white or pale brown colour. These calculi consist of nearly pure oxalate of lime in a crystalline form. Dr. Yelloly, on analysing the calculi in the Norwich Hospital Museum, met with not less than twenty examples of such crystallisation. The author has removed by lithotomy a calculus consisting of pure oxalate of lime, and of

¹ *Annalen der Physik*, Band 41, p. 393.

² *Guy's Hospital Reports*, series i. vol. vii. p. 213.

³ See Preparation 2139⁴⁵ in the Guy's Hospital Museum.

a pale brown colour, which crumbled to pieces immediately after extraction, a circumstance which was due to the almost entire absence of any binding material.

The third variety is the pure white oxalate-of-lime calculus. This is of a milk-white colour, possesses a highly polished surface, is of extreme rarity, and is generally if not always found in the kidney; its external surface presents no crystals, but is perfectly smooth, though it may be spinous.¹ This variety seems to have escaped the attention of writers on Stone.

In the Museum of the Norfolk and Norwich Hospital are three specimens: the first, a moist preparation representing a renal calculus of cauliflower shape and of great magnitude; it occurs in the form of a single mass, filling a greatly distended pelvis. From this mass there branch out other smaller masses, which fill up the infundibula. The whole kidney is greatly enlarged. The stone is extremely white, quite smooth, very hard and compact, and polished; it resembles Parian marble. The only circumstance known of its history is, that the preparation was removed from a man after death.

The second example is a small calculus, very smooth and shining, weighing ten grains, about the size of horse-bean, said to have been passed by an adult female. On analysis it yielded oxalate of lime.

The third specimen is nearly spheroid in shape, and about the size of an ordinary marble; it is of a white colour, though not so polished as the above two are; its external surface is covered with spines and tubercles peculiar to the 'mulberry calculus,' which it most closely resembles in everything but colour. Its tubercles are smooth, *i.e.* they are devoid of crystals; its weight is forty-five grains. The catalogue informs us it was passed by a female, aged twenty, who was pregnant at the time. On scraping its surface, and placing the debris under the microscope, very minute octahedra of oxalate of lime were detected; they were insoluble in potash and acetic acid, and thus distinguished from other substances which they resemble.

In reference to this Mr. Williams remarks: 'I am inclined to believe that the pure white colour of the third variety of oxalate-of-lime calculus is due to the circumstance that it is met with only in the kidney, and that while in that organ it is not permitted to lie continuously in urine, and therefore cannot acquire the dark brown or almost black hue which the oxalate-of-lime calculus generally assumes when situated in the urinary bladder. The tuberculated form of this calculus, in consequence of its roughness, causes the mucous membrane of that viscus (the bladder) to pour out blood far more frequently than any other variety of calculus; and there can be but little doubt that the colour is derived from the hæmotosin, which has been abstracted by the urine from the blood-corpuscles, and remains suspended in it.'²

While in the kidney, the constant trickling of urine over this variety of stone gives rise to its smooth white surface.

5. The *cystic oxide*, or *cystine calculus*, discovered by Wollaston in 1810, is a rare calculus. It differs from all others in containing a considerable proportion of sulphur, according to Dewar, nearly 27 per cent.³ The calculus is not a product of the bladder, as its name would seem to imply, but of the kidneys; and there is a remarkable hereditary disposition to its formation, for out of 22 collected cases, 10 occurred in four families, and in three cases the subjects of the complaint were brothers. Ten specimens in the collection of Guy's Hospital were passed by the same patient, whose age was 30; three were passed in the year 1814 (No. 2144), 6 small ones subsequently (No. 2145), and in 1828 another remarkable one, of the shape of an ear-drop (No. 2145³⁵).

These calculi are usually small in size; the largest is in the University College Museum, and weighs 850 grs.; at St. Bartholomew's there is one weighing 740 grs. The one at Guy's Hospital (No. 2143), the second specimen analysed by Dr. Wollaston (the discoverer), is described by him in the 'Phil. Trans.' for 1810; it is an inch and a-fifth long and one inch broad.

They are described to be generally rounded and smooth, but may be covered either with smooth tubercles or sharp projections externally; they have a wax-like lustre, appear semi-transparent and glistening, and resemble very much the ammoniac-magnesian phosphate calculus. When recent, their colour nearly approaches

¹ For the detailed account of this variety we are indebted to Mr. Charles Williams, formerly House-Surgeon to the Norwich Hospital.

² Hæmorrhagic urine, filtered so frequently as to lose all the corpuscles, will be found to possess the dark blood-stained colour notwithstanding.

³ Dewar, *Pharm. J. Trans.* [3], vii. 144.

that of the uric-acid calculus, being of a pale yellowish brown; they undergo, however, a remarkable change by long keeping, turning slowly from brown to grey or green. Thus the calculus in Guy's Hospital Museum (No. 2143) was brown in 1817, now it possesses a rich bluish-green colour. Their consistence is soft, and on section they present a very imperfectly radiated structure, and exhibit no tendency to a development of concentric layers; when scraped, they yield easily to the knife, and form a perfectly white powder, whether the calculus be brown or green. The fracture is crystalline.

6. The *phosphate-of-lime calculus*, discovered by Wollaston in 1797, is likewise rarely found in the bladder uncombined with other salts; and it seldom forms the nucleus of other calculi. Calculi chiefly or entirely composed of it are tolerably hard and smooth externally, not presenting the angular asperities of the oxalate of lime, or the contorted and irregular figure frequently assumed by the fusible calculus: sometimes they consist of two or three portions fitting into each other in a variety of ways.

Of three specimens in the Guy's Hospital Museum, the first (No. 2148) presents a porcellaneous appearance externally, admitting of considerable polish by friction; is conchoidal in its fracture, and is of a greyish-white colour; the second (No. 2149) is more regular in figure, and is made up of a series of concentric layers of the phosphate, readily distinguished from each other by their tint, being alternately white and fawn-coloured; the third (No. 2150) is light-coloured, and has a spongy, cancellated structure, and looks more like a bony concretion than a deposition.

There are, however, two varieties of this form of calculus: the one, as described by Wollaston, of renal origin, and consisting of neutral phosphate of lime; and these are usually pale brown, with a smooth polished surface regularly laminated, and the laminae so slightly adherent as to be easily separable into concentric crusts; in some, radiating lines are seen in a direction perpendicular to the laminae; these calculi contain a considerable proportion of animal matter. The other form is of vesical origin, and composed of phosphate of lime, similar to that of bones, and hence often called 'bone-earth' calculi; they are more common than the former, and constitute irregular masses resembling mortar, or a granular semi-crystalline powder, enveloped in a tenacious mucus. Dr. Taylor, in the 'Catalogue of Calculi of the Royal College of Surgeons, England,' has described some specimens as consisting entirely of this salt.

The phosphates are scarcely ever succeeded by any other form of calculus, but there are three instances in which a phosphatic calculus was succeeded by uric acid or urate of ammonia, and in one instance it was followed by oxalate of lime; the general ratio in which they succeed other deposits is one to four and one-fifteenth. Foreign bodies as a rule have earthy phosphates deposited upon them; but there is one remarkable exception ('Cat. of the Royal College of Surgeons of England,' Plate iv. fig. 6) where a slender piece of steel formed the nucleus of a large oval calculus, consisting almost entirely of uric acid.

Respecting the earthy phosphates in calculi Dr. Thudichum remarks: 'Not quite ten per cent. of all calculi have a nucleus of mixed phosphates; but these substances enter into the composition of about thirty-four per cent. of all calculi, forming either their body, one or more layers, or the crust. This shows that the presence of deposits of mixed phosphates in the urine scarcely ever gives rise to the formation of calculus, but that the presence in the bladder of other calculi frequently cause a deposit of phosphates to be formed around them, in which respect every calculus is nothing else than a foreign body. For such a concretion to form, it requires the presence of some binding material, such as ropy mucus, or a clot of blood or fibrin, in hæmaturia and chronic disease of the mucous membrane of the bladder.'

7. The *triple-phosphate calculus*, or ammoniaco-magnesian phosphate, also discovered by Wollaston in 1797, is rare.

There are three specimens of this calculus in the Museum of the Royal College of Surgeons of England, and one or two only at Guy's Hospital: in the former collection they appear

as a white crystalline mass, radiating from the centre, and having the surface studded with shining crystals, which, when recent, are nearly transparent, but by exposure become opaque; their texture is earthy, friable, and imperfectly lamellar; some are hard and compact, semi-transparent, and crystalline in fracture like alabaster. In the Guy's collection (No. 2154) a calculus of this kind is to be seen which has no nucleus, but a central cavity lined with delicate crystals of triple phosphate, resembling the crystals of quartz in the cavities of flints; and No. 2152 is a section of a large calculus of the kind on a nucleus of a tobacco-pipe. Dr. Thompson mentions a calculus of this sort weighing nearly 2 lbs.

8. The *fusible calculus*, or mixed phosphate, or the phosphate-of-lime and phosphate-of-magnesia and ammonia calculus, discovered by Wollaston in 1797, is the most frequent of the phosphatic calculi, and forms rather more than one-twelfth of all calculi, being rarely succeeded by any other species of urinary deposit; their relative proportions in the several collections are various, from one in eight and a half to one in thirteen and a half.

These calculi grow to a considerable extent, and are comparatively light and of low specific gravity; they are generally very irregular, and mould themselves to the situation in which they are placed, often filling the interior of the bladder, and becoming impressed with its rugæ; sometimes they are globular and ovoid, at other times taking on the most extraordinary shapes; where there are two or more, they assume a cubic or tetrahedral form. Their colour is white, grey, or dull yellow, and their consistence is more friable and earthy than any other variety, and is sometimes so soft as to resemble moist chalk.

Their appearance on section is thus described by Dr. Taylor (*op. cit.*): 'They are frequently composed of concentric laminae, which in general adhere but slightly to each other; between the laminae shining crystals of the triple-phosphate are often observed; in some the laminae are entirely wanting, and these form a white friable mass like chalk; in others they appear semi-crystalline, as if made of numerous small crystals confusedly aggregated together. The relative proportion of the constituents of this calculus is exceedingly various, and the predominance of one or the other salt gives peculiar characters; in those which have a crystalline and glistening texture the triple-phosphate is most abundant, while the calcareous phosphate is in excess in those which have an amorphous earthy appearance.'

It generally constitutes the calculous masses deposited on foreign bodies accidentally or intentionally introduced into the bladder.

9. The *carbonate-of-lime* calculus, discovered by Brugnatelli in 1819, is a very rare form indeed.

He describes ¹ forty-eight small concretions extracted from the bladder of a young man: these were of the size of a pea, lamellar in structure, and broke with a shining fracture. He also mentions several ash-coloured calculi, sixteen in number, and of the size of a nut, which were composed of carbonate of lime with a trace of carbonate of iron; these were removed after death from the bladder of a woman. Dr. Prout has also seen small calculi of this salt, and these were perfectly white and very friable.

In Guy's Museum (No. 2182⁷⁷) there are some calculi of carbonate of lime, with mere traces of carbonate of magnesia and alumina; in one specimen (No 2187⁹⁰) it constitutes the body of a calculus, being deposited of a snow-white colour, on a nucleus of uric acid. There are several in the Oxford Museum, among the collection of Mr. Hitchins, and there is in the possession of Mr. R. Smith of Bristol a remarkable collection of these calculi, some of which are figured in the 'Catalogue of the Royal College of Surgeons of England,' Plate xii. figs. 3, 4, 5, 6, and 7.

Prostatic calculi sometimes consist almost entirely of this substance, but, as Dr. Thudichum observes, 'it is always questionable whether the lime or the carbonic acid were in any case derived from the urine.'

10. The *fibrinous calculus* of Dr. Marcet and of Dr. Prout is by some not ranked among calculi, in consequence of its differing so totally from those other concretions. Dr. Bird ² says: 'It must be regarded as a portion of dried inspissated aluminous matter exuded from an irritated kidney, rather than as a calculus produced under circumstances at all analogous to those of other concretions. Several specimens exist in the Guy's Museum of the pelvis of the kidneys and

¹ *Litologia Umana*, Pavia, 1819.

² *Guy's Hospital Reports*, series i. vol. vii. p. 180.

ureters being obstructed by clots of fibrin; but none of them present the hard concrete condition of the calculus described by Dr. Marcet. I am not aware of this variety having been mentioned by any other author except Brugnattelli, who, in his 'Litologia Umana,' describes some calculi as consisting of crystallised albumen; they were passed by one individual, and each was about the size of a nut. 'These pseudo-calculi appeared to consist of dried coagulated albumen, which not unfrequently presents considerable lustre and a vitreous fracture, although scarcely sufficient to justify its being regarded as crystallised.' Some have described it to resemble yellow wax in appearance, and others have regarded it as an elastic organic substance closely allied to fibrine.

11. The *uro-stealith calculus* is another of the pseudo-forms: it appears to consist of fatty matter in combination with lime, forming a kind of soap. (Cf. Dr. Dickinson on 'Diseases of the Kidney,' now (1881) in the press.)

It has been described in Heller's 'Archives' (1844, p. 97, and 1845, p. 1), and it consisted of several small bodies composed of a peculiar form of fatty matter which were passed by a man aged 24, who suffered from symptoms of stone in the bladder. Dr. Moore of Dublin has confirmed the existence of this substance, and has examined several specimens sent to him by Dr. Robert Adams of Dublin.¹

12. *Blood calculi* have been but recently discovered, and are likewise pseudo-calculi.

Those described by Dr. Alison² were found in the infundibula and pelvis of the kidney of a painter aged 52, who died of consumption; black calculi occupied the pelvis, while the infundibula were tenanted by a few calculi of a whitish-grey colour, with one exception small in size, about the magnitude of pear-seeds, and wanting the ordinary physical characters of phosphate of lime. One calculus which occupied the infundibulum was the size of a horse-bean, looked somewhat worn and disintegrated, and at one point resembled a piece of decayed wood, and was black on one side from the presence of altered blood; it was of low specific gravity, and was composed of blood and phosphate of lime. The black calculi, which formed the chief point of interest, were about six in number, and ranged from the size of a coriander-seed to that of a small horse-bean; when found, these black calculi were tolerably hard, but being friable they broke asunder on handling; the fractured surface varied a little in colour, in some parts presenting a dark rusty appearance. Liquor potassæ dissolved them, and they were capable of partial combustion; the microscope revealed only amorphous particles, but Dr. G. O. Rees, with the assistance of a neutral saline solution, discovered forms which he considered to be the remains of blood-corpuscles.

Silicious concretions are not met with, although silica has been found in other calculi by Berzelius and others.

13. A case of *ferric oxide calculus* is described in the 'Dublin Q. J.' vol. lxii. p. 428.

A. POLAND, 1870.

W. F. DONKIN, 1882.

¹ *Dublin Quarterly Journal of Med. Science*, May 1854, p. 473.

² Dr. Scott Alison, *Archives of Medicine*, vol. i. p. 245.

LITHOTOMY.

VESICAL CALCULI: RELATIVE PROPORTIONS MET WITH.

STONE in the bladder exists, as has before been shown, chiefly in three varieties of chemical constitution: viz. uric acid and the urates; phosphates of lime and ammonia; and oxalate of lime; and each product is known by the name denoting its chemical constitution. Besides these, among one or two other very exceptional products, cystine need only be named as a formation of great rarity. The three chief rarities named, or any two of them, frequently coexist in a single calculus; hence 'mixed' calculi are spoken of. The most frequently occurring are those belonging to the class of uric acid and its combinations; amounting to fully one-half of the entire number, embracing all calculi; one fourth are phosphates, and nearly a fourth may be placed to the 'mixed' class, chiefly of urates and phosphates; while the oxalates may be estimated at about three per cent. of the whole.

In most cases of stone in the bladder, one stone only is present; not unfrequently, however, there are two or more, especially of the uric acid variety; and of this examples are occasionally numerous. I have removed from forty to eighty calculi at a single operation; and in one case I emptied a bladder of at least 700 or 800 minute uric-acid calculi by washing out, on two or three occasions; the whole weighing little less than an ounce. Sometimes a calculus may be so large as to fill the entire cavity of the bladder; the formation is then mostly phosphatic, and is friable in character, since this material is produced with much greater rapidity than the other varieties; while the oxalate, being the slowest in depositing, is therefore the hardest of all. As a rule, to which the exceptions are excessively rare, calculi are quite free in the cavity of the bladder, unattached in any way to its walls. But now and then it happens that a calculus is encysted, in which case it usually occupies one of those cavities which are not uncommon in some old and diseased bladders, and which are known as sacci. In these circumstances it is by no means possible always to remove the calculus during life. (See examples referred to under the section 'Difficulties met with in Lithotomy,' p. 276.) More rarely still, a calculus may be adherent to the coats of the bladder; a condition sometimes affirmed to exist, when there is not sufficient warrant for the statement; as when unusual difficulty in extracting the stone in lithotomy has been encountered. At most, two or three undoubted cases of such adhesion have been verified after death; and in these the stone, of which the outer part at any rate has been phosphatic, was found attached by a portion of its surface to a granular diseased mucous lining of the bladder.

Sometimes also calculi are found embedded in the structures anterior to the neck of the bladder, and are met with in cutting through the perinæum, lying in a kind of cavity partly urethral, and partly formed among the tissues outside. (See 'Difficulties met with in Lithotomy,' p. 278.)

Certain local influences are supposed to exist, favouring the formation of stone; thus it is said to be more frequent in temperate than in warm or cold regions; of which, however, the prevalence of stone within the tropics and adjacent regions, such as India and the Valley of the Nile, as well as on the banks of Russian streams north of Moscow, furnishes a sufficient refutation. But stone is much more common in particular districts of the same country than in others; to wit, on the eastern shores of Great Britain, particularly in Norfolk, Yorkshire, and Aberdeenshire, while in the western counties it is almost unknown. The use of cider, the hardness of the natural springs, and various local foods, have been adduced as sufficing to account for

the difference in question; but this is not, in my opinion, produced by any such, or probably not by any single circumstance. Let one such fact as the following only be noted: viz. that unduly large deposits of uric acid, the commonest formation in calculous disease, may be greatly, if not entirely, subdued by appropriate diet and habits; and thus it may be regarded, like articular deposits of uric acid, as an hereditary complaint, as gout is universally admitted to be. Stone is much less frequent in females than males, the proportion being about one to twenty or more. This is due to the shortness of the urethra in the female, and its dilatability, perhaps also to the comparatively temperate and regular habits of life of females.

Calculi are most frequently met with in the young and in old people. This subject I have studied with great care, and can offer what may be accepted as trustworthy evidence, to the extent of 1,827 cases collected by myself from original sources.¹

These cases are derived from the entire experience, during given periods of time, of the following hospitals: Guy's, St. Thomas's, University College, Norwich, Cambridge, Oxford, Birmingham, Leicester, and Leeds. It is quoted in a foot-note,² and the statistics derived from this table may be arranged according to the different epochs or periods of life. Thus, under puberty, from 1 to 13 years of age, there are 940 cases, or 51·45 per cent. of the whole number; and this may be subdivided into two phases, viz. infancy and childhood, from 1 to 5 years, 473 cases, or 25·89 per cent.; and boyhood, from 6 to 13 years, 467 cases, or 25·56 per cent. At puberty, and during adolescence and approaching manhood, from 14 to 26 years, 228 cases, or 12·47 per cent. During the next ten succeeding years, from 27 to 36 years, 80 cases, or 4·37 per cent. At adult life, from 37 to 49, 127 cases, or 6·95 per cent. In advancing life, from 50 to 70, 414 cases, or 22·65 per cent.; and in old age, from 71 to 81, 38 cases, or 2·07 per cent.

At what period of life, then, is an individual most liable to be affected with calculus? It has been common to answer, in childhood. A superficial glance at these figures might confirm this opinion. I believe, however, that it is the period between fifty and seventy years, and of this the latter half of the term especially. Certainly, the proportion of elderly calculous patients to the existing population at advanced age is much larger than the proportion of children afflicted is to the number of existing children. This is the only accurate method of viewing the question. Calculus is most common between fifty and seventy; appears in the next

¹ *Practical Lithotomy and Lithotrity*, by Sir H. Thompson, 3rd edit. (Churchill, London, 1880), pp. 111 and 225.

² *Table of Prevalence of Stone in 1,827 Cases of Lateral Lithotomy at Different Ages:—*

Age	No. of cases	Age	No. of cases	Age	No. of cases	Age	No. of cases
1	7	22	10	43	11	64	16
2	74	23	9	44	4	65	26
3	116	24	12	45	17	66	20
4	153	25	11	46	11	67	14
5	123	26	10	47	15	68	17
6	90	27	5	48	6	69	8
7	86	28	6	49	10	70	16
8	49	29	11	50	23	71	8
9	57	30	11	51	15	72	5
10	60	31	3	52	11	73	4
11	35	32	14	53	17	74	2
12	58	33	7	54	25	75	9
13	32	34	9	55	23	76	4
14	35	35	9	56	26	77	0
15	26	36	5	57	25	78	1
16	27	37	3	58	16	79	0
17	18	38	14	59	22	80	4
18	26	39	4	60	33	81	1
19	19	40	21	61	17		
20	13	41	4	62	22	Total .	1,827
21	12	42	7	63	22		

degree of frequency between two and six years ; and, least frequently of all, perhaps, between twenty-six and thirty-six years—when, indeed, it is rare.

The condition and habits of life have some effect as a cause. Thus sedentary habits impair the functions of the skin, and give increased work for the kidneys ; but especially luxurious feeding and use of malt-liquors and nitrogenised food in excess augment uric-acid deposits ; while inordinate use of saccharine matters is an undoubted cause in some constitutions.

Respecting the exemption of sailors and soldiers from this disease, as alleged by Mr. Copland Hutchinson and others, further inquiry is desirable.

Morbid states of the urinary passages may predispose to calculous formations, and more especially the presence of a foreign body, which is sure to cause a precipitation and deposit on its surface.

Symptoms of stone in the bladder.—Whatever may be the nature of the calculus, when once it exists in the bladder, it acts as a foreign body, and generally gives sufficient evidence of its presence by inducing certain symptoms, which may enable the surgeon to detect it. Of course all these symptoms are not uniformly met with ; they may vary under the influence of different external circumstances, and in different constitutions.

The evidence that a stone is present in the bladder is of two kinds : first, that afforded by the patient's sensations and by the physical signs observed ; both of which together may produce a strong belief as to the cause, but do not suffice to establish the fact ; and, secondly, the evidence obtained by a physical examination, the only method of deciding the question, is there or is there not a calculus in the bladder ?

In relation to signs and symptoms, we may first learn of the patient that he has passed some gravel or small stones at different times ; or at all events that he has had some attacks of nephralgia. He complains of undue frequency in passing water, more especially when moving about ; less observed at night when he is at rest. In prostatic hypertrophy the reverse is observed, and the difference should be noted as diagnostic. Pain is an almost invariable concomitant of stone ; it is described as a burning or smarting, mostly felt at one spot about an inch from the meatus externus, and beneath. Felt at any time in some circumstances, it is almost always present in the act of making water, during and at the end of the act, and for a short time afterwards ; and it is aggravated by quick or jolting movements. One of the most useful signs in relation to diagnosis is the effect of movements on this pain : the calculous patient suffering very little when remaining quiet or at rest, but beginning to be troubled both by pain, and frequent micturition when he takes exercise, the trouble being for the most part in proportion to the amount and violence of the movements. The appearance of a little blood in the urine is another very constant sign of stone, and its appearance also is in direct proportion to the degree of locomotion permitted. The same result may be noted in those much rarer forms of vesical disease, villous or cancerous growths ; but in these the hæmorrhage is often considerable, a phenomenon almost unknown in simple calculus, where the bleeding is always slight. Changes in the urine may be present, but are by no means regularly so ; and these also arise in proportion to the amount of movement, and consist of mucous deposits with streaks of blood ; and if the stone has long been present, and is large, or if it be phosphatic, the amount of muco-pus in the urine may be considerable.

To sum up : if a patient has passed gravel, complains of pain in the glans penis at the end of micturition, has unduly frequent micturition, sees a little blood in his urine, all these manifestly augmented by exercise, it is next to certain he has a calculus in his bladder. In these circumstances there should be no delay in ascertaining the fact by sounding the bladder. It is right to mention that, associated with the ordinary and obvious symptoms described above, there are others of less note and importance. Such are tenesmus of the bowel and frequent defæcation ; in children, prolapsus and constant handling of the prepuce ; rarely is there any obstruction to the flow of urine ; occasionally pains in the limbs, supra-pubic and

perinæal pains of cystitis when that condition is present. The sign commonly noted in books, of frequent sudden stoppage to the stream of urine is literally almost unknown.

Sounding for the stone.—The physical signs of stone in the bladder are derived from mechanical means affording by the senses of touch and hearing distinct evidence of its presence to the surgeon. The bladder is explored with a solid metallic instrument, which, on coming in contact with the stone, produces a ringing noise or sound; hence the term ‘sounding’ given to the operation, and ‘sound’ given to the instrument used.

The sound differs from a catheter both in size and form; and is made of steel, well polished on its exterior, its length and size varying according to the age of the patient undergoing examination. The handle may be expanded and flattened, or cylindrical, in order to give a larger surface for the fingers and thumb of the operator to receive vibrations. The curve is much shorter than that of the ordinary catheter, and more or less angular (see fig. 34). A sound with a large curve may glide over a calculus, when lodged in a depression behind the prostate: hence one with a short beak should be always employed.

The position of the patient in sounding should be the recumbent one; the pelvis a little elevated, and the bladder may be moderately distended with urine. The sound should be introduced carefully and slowly, and allowed to glide along the canal by its own weight; no force whatever is required, and in general little pain need be given. Having arrived at the bladder, the point of the instrument is to be made to move gently from side to side, then from before backward, and then rotated slightly with the beak downwards, so as to explore the floor, after having gently depressed the handle between the patient’s thighs. Occasionally the exploration may be facilitated in obscure cases by the introduction of the finger into the rectum, or by making pressure with the hand above the pubes. In consequence of some fulness about the rectum, the stone is sometimes found lodged on either side; but it often lies close to the neck of the bladder, and is passed over, and so missed in sounding.

Sounding not only enables the surgeon to detect the presence of calculi, but it assists him in ascertaining their size, number, situation, and sometimes density. The size is determined by first traversing the surface of the stone with the convex part of the sound from side to side, and then carrying the point from before backward. The presence of more than one stone may be sometimes detected by careful exploration, although this may prove deceptive. The situation of a stone may likewise be made out, as to its being loose and free, or fixed and encysted, the latter being a very rare condition.

The noise emitted on the striking of a stone corresponds with the size and density of the calculus: small and very movable calculi give but a feeble sound; smooth and dense calculi, as lithic acid and oxalate of lime, afford a clear ringing one; light, friable, phosphatic calculi emit a dull and scarcely appreciable sound. The smooth surface of a lithic-acid stone, and the rough irregular exterior of the oxalate of lime, may in most instances be detected by the instrument.

Difficulties and sources of fallacy in sounding are not at all unfrequent. Thus, a stone may be detected at one time, and not at another, owing either to its smallness or to its being temporarily hidden in the folds of the bladder; in fact, small stones easily escape detection, and are often better found when the bladder has just been emptied, in which case a beaked sound of angular form mostly meets with them just at the neck of the bladder, as the instrument enters the cavity.

But a stone may be missed by the surgeon, when the bladder is atonied and distended with urine, a large quantity of fluid in the bladder being very prejudicial in relation to successful research. A calculus with a very soft external layer of phosphatic matter is by an inexperienced hand undistinguishable from a tumour or enlargement of the prostate, no sound being elicited by a tap from the instrument, as when a hard stone is present. The doubt may be cleared up sometimes by using the flat-bladed lithotrite, which will not only enable the operator to seize the foreign

body, but will also enable him to ascertain its size—one of the important objects to be attained by sounding. The nature of the operation to be performed depends mainly on the size and texture of the calculus; so that not merely its presence, but its physical qualities, should be ascertained before a choice of operative proceedings is made. The sensation communicated by the calculus to the hand through the medium of the sound has already been referred to; the differences between grasping a phosphatic, uric, and oxalic calculus in the lithotrite are still more marked and significant to the hand of the surgeon. Thus the first-named offers a gritty but yielding sensation on pressing the male blade upon it after it has been caught; the uric-acid calculus is firm and resisting, but yields obviously somewhat to the hard pressure of the screw; while an oxalate-of-lime calculus is unyielding to ordinary pressure, and is felt within the jaws of the instrument almost like a piece of porcelain, on which their edges make no 'bite' or impression. In crushing, the teeth gradually penetrate the other kinds; the last-named splits with a sudden crack. So it is, that after a little practice there is rarely any difficulty in determining the nature of the calculus struck or seized before seeing it, while its size is easily ascertained by catching it, say, in two diameters.

In the female, vaginal examination is important, and on making pressure above the pubes at the same time, the stone may in most instances be felt. It is worthy of note that the stone is very frequently not close to the neck of the bladder, but lying at the side, either right or left. Uterine disease, a source of fallacy as simulating stone, is not to be overlooked.

The prognosis of this complaint must always be serious; there are no means of removing the stone but by operation, without which death is the sure consequence at a more or less remote period. Spontaneous expulsion of a small stone through the urethra is common enough, and in some rare instances nature has effected a cure by causing a large one to be extruded by ulceration through the rectum, vagina, or perinæum. These, however, are extremely rare cases. The surgeon also has to bear in mind that, although a stone has been successfully removed, yet not unfrequently other stones may be subsequently formed.

The progress and termination of the disease are exceedingly painful and distressing, and vary with the condition of the calculus, the constitution of the patient, and the age and temperament of the individual. In some instances the symptoms are not severe, and may exist for many years without exciting any great distress. But in ordinary cases, if not removed, there is constant increase of symptoms; the patient becomes thin and worn-out, the health impaired, the micturition frequent and distressing; atony and atrophy of the bladder take place, so that there is inability to void the urine except in the reclining posture: this secretion becoming ammoniacal, offensive, and finally loaded with blood and mucus. Prolonged sufferings occasion exhaustion and emaciation until death closes the scene.

The post-mortem appearances of those who have died with a calculus in the bladder will of course vary, according to the mode of death and the complications which have previously existed. Ordinarily they will consist of chronic cystitis and chronic inflammation of the ureters and pelvis of the kidney, with slow changes in the glandular structure of the organ.

Treatment.—During the long history of this malady, which, unlike most others with which we are now familiar, extends to not less than two thousand years, a great variety of methods of treating it, both by medical and surgical means, has been tried. In brief terms, it may be said that these consist in—

1. Efforts to dissolve the stone by medicines taken internally.
2. Its solution by chemical agents introduced into the bladder.
3. Its removal entire, by mechanical means; chiefly by cutting operations.
4. Its removal, after crushing into small débris, through the urethra.

1. *Solution by internal remedies.*—One of the earliest allusions to this treatment is found in Pliny, who says 'that the ashes of burned snails' shells are good for expelling the stone.' In tracing the records which exist from that time to the present

day, it is certain that all the remedies employed, whether by the numerous empirics who have vaunted their powers to dissolve the stone, or those agents employed by the medical profession, belong to the class of alkaline earths, or to that of the alkalies proper. The empirical remedies have been mainly solutions of lime, soda, and potash; the medical agents have been the same salts, chiefly those of potash, and more lately in combination with lithia. The subject has been well studied by Dr. W. Roberts of Manchester,¹ and the conclusions which have been arrived at may be presented as follows: (1) That a small uric-acid calculus is the only form with which there is any prospect of succeeding by way of treatment by solution. (2) That in circumstances of the most favourable kind, a course of several weeks must be devoted to the internal use of potash, and some diminution in size may be effected. (3) That there is no evidence at present existing in any quarter to warrant a belief that the attempt to dissolve a stone has ever been successful.

2. *The solution of stone by means of chemical agents introduced into the bladder.* The injection of solvents into the bladder has also been sedulously tried, and many experiments have been performed on calculi to ascertain their solvents, which have then been employed by means of injection into the bladder through a catheter. Unfortunately the solution, if strong enough to be of any use, endangers the coats of the bladder, and when diluted its action is feeble. Diluted alkaline solutions have been recommended for uric-acid calculi; diluted acids, such as the nitric and hydrochloric acids, for phosphatic. For the phosphatic formations alone, which are often very loose in texture and friable, is it possible to obtain any result by such proceedings. In the early stage, when indeed the triple phosphate exists in merely aggregated masses of prismatic crystals, much benefit may be obtained by the free use of solutions thrown into the bladder. After many trials I know none so efficient as a weak solution of the acetate of lead, say from one grain to a grain and a half in four ounces of water, slightly acidulated with distilled vinegar. This should be used once or twice daily, with a gum catheter and a four ounce india-rubber bulb, making small and repeated injections of the bladder on each occasion; and leaving perhaps an ounce of the solution behind in the cavity.

The dissolution of calculi by electricity (electrolysis) has also been attempted by many experimenters within the last fifty years, but without success. The mechanical means for removing calculi have been so greatly improved of late that little chance of a better, more speedy, or less irritating method seems likely to be available either from chemical or from electrical agencies.

3. *Removal of calculus by mechanical means; chiefly by cutting operation.*—Extraction by mechanical means without the knife is limited to a small class of cases. In the early stage, when the calculus is small, we may assist nature in its expulsion from the bladder by administering alkaline purges, by dilating the urethra with a large bougie, and giving diuretics; the bladder should be allowed to retain as much urine as possible, and then a free and copious evacuation may carry the stone along with it, or it may be washed out with a large evacuating catheter. Should the calculus become lodged in the urethra, it may be extracted by means of forceps, such as described and used by Hunter, Civiale, Sir A. Cooper, and others.

In females this plan is very practicable, and we shall refer to it hereafter.

We shall now consider the removal of calculus by means of an artificial opening—in other words, the operation of lithotomy. There are three situations in which it may be performed—viz. in the perineum, in the hypogastric or supra-pubic region, and through the rectum; each of which will be considered.

I. PERINEAL LITHOTOMY.—There are several methods by which a stone may be removed from the bladder through incisions made in the perineum: the first which will be considered here is that known as the 'Lateral Lithotomy.'

¹ See his work, *Practical Treatise on Urinary and Renal Diseases*.

And we shall commence with the instruments which should be ready for use before performing the operation. The non-appearance of a single instrument of importance when required may produce great embarrassment to the operator; hence a list should be prepared, so that the instruments can be selected beforehand.

One or two ordinary sounds for examining the bladder.

An eight-ounce syringe, with suitable catheter for injecting by urethra; and a tube for washing out the bladder by a reversed current through the wound after the operation (figs. 51, 52).¹

FIG. 51. — The Syringe, with graduated piston-rod.

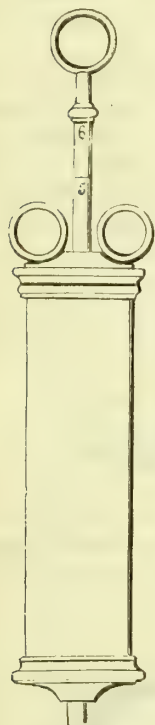
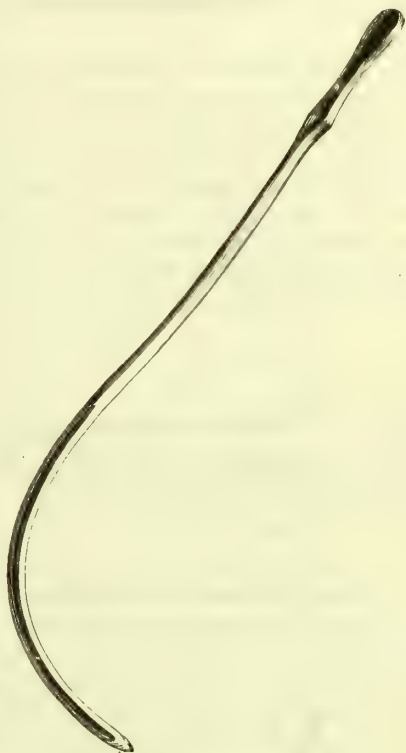


FIG. 52. Nozzle for Reversed Current.



FIG. 53.—Staff, with lateral groove.



Staffs of full size for the adult, or small, if for children: all as deeply and widely grooved as the size admits; the groove to be midway between the convex and the lateral aspects of the staff, to stop abruptly half an inch from the extremity, and not to extend so far up the handle as to permit the urine to escape (fig. 53). The curved portion not to be so long as it is usually made, since a small or contracted bladder is sometimes exposed to the danger of perforation when that portion of the staff protrudes far into the cavity.

A knife, of which the blade and handle together measure (for the adult) about

FIG. 54.



seven and a half inches long; of this, the blade may be about three inches. The cutting edge should have a length of about one inch and a quarter from the point.

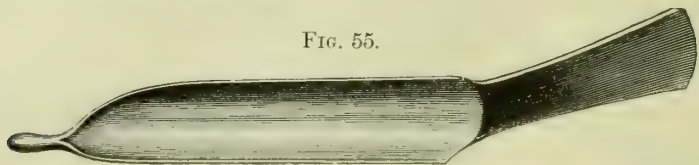
Some operators use also a second knife, of which the blade and handle may measure together about eight inches; of this the blade may be about three and a half inches; with a probe point at the end of the blade, so that it may run easily in the

¹ This nozzle is after the suggestion of Dr. Gross of Louisville; *Urinary Organs*, 3rd ed. p. 248.

groove of the staff. The cutting edge should extend to about one and a quarter inch from the point.

A blunt gorget about five and a half inches long, exclusive of the handle, curved from side to side and terminated by a probe point, to run in the staff (fig. 55). This

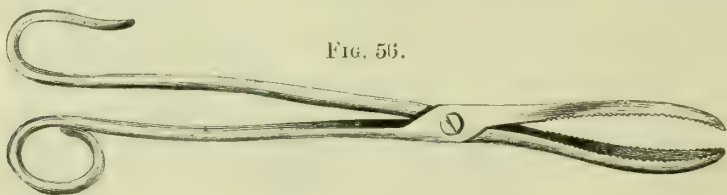
FIG. 55.



is a useful instrument where the perinaeum is so deep, or the prostate so large, that the finger cannot reach the bladder, as occasionally, but rarely, happens.

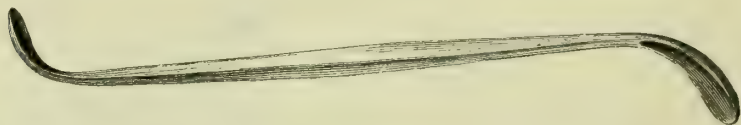
Forceps of various forms and sizes. It is desirable to have the blades of good length, so that the angle produced by opening them is acute rather than the reverse: a better form of wedge is thus presented to the orifice, through which the instrument and the stone have to pass. The inner surfaces of the blade should be slightly roughened. The extremities of the blades must not meet; an interval of about one-eighth of an inch should exist between them when the instrument is closed (fig. 56). It is necessary to have curved as well as straight forceps.

FIG. 56.



A scoop is sometimes useful, and succeeds in certain circumstances in removing a stone, or fragments, better than the forceps (fig. 57).

FIG. 57.



An instrument for searching the bladder after the operation; nothing answers better than the ordinary sound.

A strong instrument for crushing a calculus of unusually large size, and requiring to be broken before removal, is occasionally necessary. Several forms have been designed, but almost all consist of a pair of ordinary strong forceps, with screw or other power to approximate the handles. Many of those usually met with are not sufficiently powerful; for a large and hard stone requires, in order to accomplish its effectual crushing within the bladder so that the fragments may come safely through the wound, an amount of force to be applied far exceeding that which most persons who have not thus operated would conceive to be necessary. The inner surface of the blades should be somewhat rough and irregular, or one blade may be narrower and smaller than the other, but there should be no teeth or other projecting eminences, as these make it very difficult to seize the stone.

A pair of worsted web lithotomy garters, strong, but pliant; each measuring not less than three yards. A leather anklet, with strong hook, by which it is attached to a leather wristband, to accomplish more easily and more securely the same purpose, has been designed and employed by Mr. Prichard, of Bristol.

We have used these anklets for some years, and much prefer them to the garters, as being more simple and secure.

A tube to be introduced through the wound into the bladder, after the operation, if desired. One may be specially fitted for plugging in case of deep venous hæmorrhage. But the most certain mode of dealing with severe bleeding, the ligature failing or being insufficient, is the addition of an inflatable thin india-rubber bag to the tube, so arranged around it, that while its draining action is left intact, the bag can be distended with air, through a small flexible tube provided with a stopcock (see fig. 58). It should be introduced so far that the whole cut surface is exposed to the action of the bag: indeed, the further end of this should just protrude slightly into the bladder itself. This done, and inflation being made, the distended bag produces pressure on every portion of the wound's surface, closing every inequality, and effectually stopping all the hæmorrhage. After twelve or twenty-four hours or so, a little air is allowed to escape, and the pressure is gradually relaxed, until the apparatus can be removed altogether. It was designed by Mr. Buckston Browne, and is known as the 'dilatable air tampon.'

Ligatures; artery forceps; curved needles and strong silk, tenaculum to secure any deeply-seated arteries; bandages, sponges, lint.

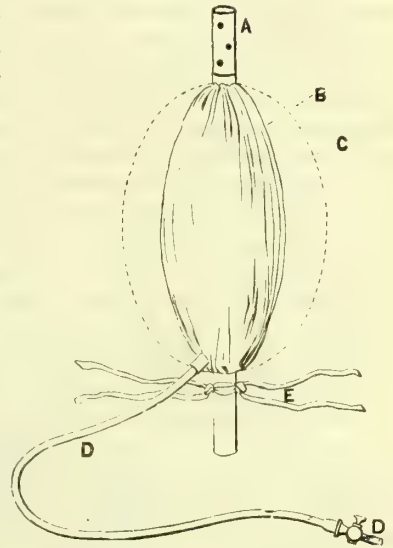
Other appliances.—Vessels containing hot and cold water, one of the former to heat the forceps and other instruments; napkins in abundance, oil; ether is of course to be given. Brandy, wine, smelling salts, and sal volatile, should be within reach.

The operator should himself see that there is a strong and steady table, of proper size, in a good light, about two feet eight or nine inches high, if the operator is seated in a chair of ordinary height; but the operator should be seated rather too low than too high; as a rule, the forearms should occupy nearly a horizontal line when operating on a level with the patient's perinæum. Some surgeons prefer the kneeling position, with one, or even both knees resting on the floor. A blanket folded once or twice, and covered with some waterproof cloth, should be placed on the end of the table, over which the patient's buttocks will be brought. A shallow vessel containing sand or sawdust is useful to protect the floor from blood, urine, &c.

The operation.—It is usual to ensure action of the bowels by an aperient, on the previous day; but if they have been sufficiently moved in the natural manner, a purge is undesirable, since it only weakens the patient. But on the day of the operation, about two hours previous to it, a full enema of warm water should be given. The surgeon should ascertain that the action of this has been efficient and completed at least an hour before the operation, or he may find the rectum distended, and about to act when the patient is on the table; a condition in which the chances of wounding the bowel are augmented. Thus, also, time is given for a few ounces of water to collect in the bladder if desired, which would probably have been emptied simultaneously with action of the bowels. The left side of the perinæum may be previously shaved.

Some surgeons regard it as important that there should be a considerable quantity of water in the bladder; but it is sufficient to take the chance of the urine accumulating for an hour before the operation; at all events, any attempt to inject an irritable bladder is rarely of any service. Cheselden preferred the bladder empty, as the stone he said is then found close to the internal incision at the neck; whereas if the organ is full it may entangle the stone in its folds as it collapses.

FIG. 58.—The Air Tampon.



A, the tube; B, thin india-rubber bag undistended; C, line indicating form of bag distended by air; D, flexible tube, with stopcock for inflating bag; E, tapes to fasten tube in place.

There should be a steady assistant to hold the staff; it is his duty to follow implicitly the operator's instructions throughout. Two others are necessary, each to support firmly a leg of the patient; one of them to draw the scrotum a little upwards, and to the right side; or this may be done by the assistant who holds the staff. The instruments should be carefully arranged by the operator himself (on a tray or otherwise), within easy reach of his right hand, so as not to be touched, and possibly deranged, by an assistant. Ether having been administered, the staff should be introduced, and the stone struck by it, the click being heard by the operator, and by one other person at least. If, after a fair search, the stone is neither heard nor felt, no operation can take place, and the search must be resumed on another day. For, supposing the stone to be struck with the ordinary sound, and not found with the staff subsequently, it is possible that the operator may have made a false passage, and unwittingly passed the staff out of the urethra altogether; or it may have passed into an old false passage, which the sound, having a different curve, escaped. The obvious consequence is, that any operation performed on a staff so placed will not lead into the bladder, no stone will be removed, and the discovery of the error may not take place until it is too late to repair it. This unhappy accident has been known to occur, not very unfrequently, particularly in children. It could not happen if the surgeon were determined to *hear the stone struck with the staff itself*; and, especially if he has not had much experience, nothing less than this should satisfy him.

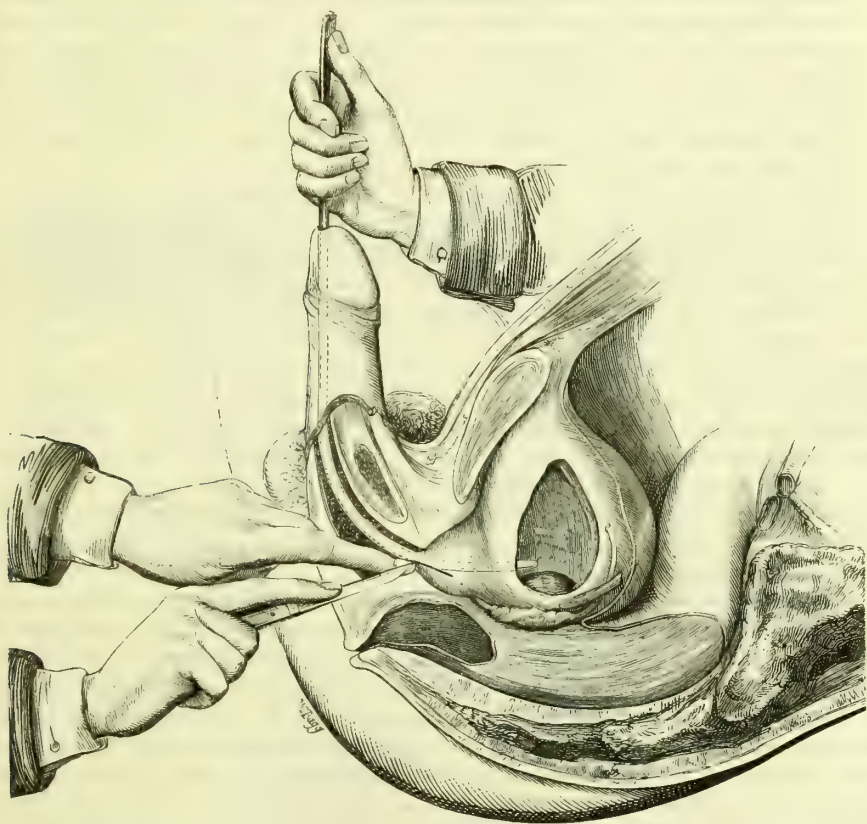
The staff being placed in the bladder and confided to the chief assistant, the patient's hand and foot of each side are to be made fast by means of the anklets described. He is then to be moved downwards towards the operator until the buttocks project slightly over the edge of the table. Each leg is firmly held by an assistant, who, facing the operator, places his nearest hand (*e.g.* his left if standing on the patient's right) on the inner side of the patient's knee, while his other grasps the patient's foot, keeping it backwards and outwards. The staff is confided to an assistant who stands on the patient's left, holding the instrument in the right hand, so that the handle is perpendicular and strictly in the middle line; and as there must necessarily be some base of support, it should rest steadily against the lower border of the symphysis pubis. In this position not more than two inches of the staff ought to be lodged in the bladder. With his left hand he may gently draw up the scrotum a little towards the right groin, and so keep it out of the way.

The operator, having placed the necessary instruments within his reach, takes his seat and separates the legs as much as he deems necessary to expose sufficiently the perineum and part of the buttocks adjacent. He ascertains that the position is square to his own front, and that the patient is firmly placed; then by passing the fingers over the perineal surface, he observes whether the tuber ischii are wide apart, or whether they approximate more than usual; and he plans the line of the first incision somewhat in conformity with the result of his examination.

He now commences by introducing his left forefinger into the rectum to ascertain that it is empty; a proceeding which appears also to have the effect of stimulating the bowel to contract and occupy the smallest possible space. He next places the fingers of the left hand upon the upper part of the perineal region to maintain the skin in its place, not to draw it upwards; and holding the sharp-pointed knife in his right, commences the first incision about a third of an inch to the left of the raphé, and an inch and a half in front of the anus, carrying the blade downwards and slightly outwards for about two and a half or three inches in a direction midway between the anus and tuber ischii, but inclining a little nearer to the latter. The knife should, at its point of entry, divide the skin, and quickly sink more deeply towards the staff, the situation of which should be kept in the mind's eye, into the superficial fascia and fat in the hollow which exists between the bulb and anus on the one side, and the ramus of the ischium on the other; the incision is then to be gradually made more superficial through its lower part. If a large stone is anticipated, its entire length may extend to fully three inches. The line of the first incision is somewhat differently taken by different operators. Nearly all agree to commence a little to the left of the raphé, but not so in regard to the distance in front of the

anus. Thus, Sir William Fergusson directed that it should commence one inch and three-quarters in front; Mr. Erichsen one and a half inch; Sir B. Brodie, Mr. Stanley, Mr. Skey, and Dr. Gross advise one inch and a quarter, while Mr. Coulson and Dr. Keith of Aberdeen preferred that it should be one inch only in advance. The latter attaches considerable importance to this point, and argues in its favour at some length in his work on the subject.¹ Mr. Crichton always made his incisions low: I infer from his notes, as near as possible to the last-named spot. It is quite clear, also, that Cheselden himself commenced about one inch in advance of the anus.² These differences are more apparent than real. The truth is that where the incisions are commenced very high, the skin only is cut at first, and where they are low, the knife is made to penetrate into subjacent tissues at once, or is pointed

FIG. 59.—Anatomy, in section, of parts interested in Lithotomy. Position of hands in last incision.



upwards, but, in any case, the deepest part of the incision is made into the hollow between the accelerator and the erector penis muscles, just beneath and outside the bulb of the urethra. Nevertheless, it should be remembered that a rather low incision avoids the bulb and the artery thereto, and places the axis of the wound in its best relation to the pubic arch—that is, as far as possible from that unyielding boundary of the perineal space. On the other hand, the lower the incision is placed, the more danger there is of wounding the rectum; and especially so, if the operator commences near the raphé, when he enters the knife at an inch or inch and quarter, instead of an inch and three-quarters above the anus.

The left forefinger now enters the wound and separates the fat and fascia in the direction of the staff, which should at this stage be just felt beneath, guarding, at

¹ *Hospital Statistics of Stone*, pp. 17–21. By Dr. Keith, Aberdeen, 1849.

² Cheselden's *Anatomy of the Human Body*, 5th ed. 1740; 6th ed. 1750: 'I first make as long an incision as I can, beginning near the place where the old operation ends.'

the same time, the rectum by pressure downwards and inwards, while the knife follows, and by an additional small stroke or two enables the operator to define clearly the line of the staff, and press his finger-nail into the groove where it lies in the membranous portion of the urethra just in front of the apex of the prostate. Guided by the nail, he carries the point of the knife into the groove at this spot, and he holds the knife so that the blade is neither vertical nor horizontal, but inclining rather more to the latter direction, while the point is directed a little upward. This important stage of the operation is illustrated by the fig. 59 (anatomical section) annexed. The knife is now pushed steadily along the groove of the staff into the bladder, the operator being careful to remember that the depth of the incision in the prostate very much depends on the angle which the blade makes with the staff in that act. The hand, therefore, must not be lowered too much; if a small incision is required, the knife is to be maintained very nearly in a line with the extremity of the staff, so as to make an acute angle with it; the point being kept up only enough to ensure its transit clearly and closely along the groove, which must not be quitted for an instant. When the bladder has been entered, the knife is withdrawn to make way for the finger, but if the operator is of opinion that more room is wanted he can enlarge the incision to the extent deemed necessary while withdrawing the blade, by carrying it outwards and downwards, in the line of its entry, so that the edge sweeps lightly along the outer angle of the wound.

The operator now slips the point of his left forefinger into the groove of the staff, and along it, slowly and steadily through the wound in the prostate, slightly dilating as it passes, until the last joint enters the vesical cavity (as it will in ordinary cases), and comes into contact with the stone, mostly felt lying at the neck of the bladder. In this position he is enabled to ascertain its situation, and, at the same time, to make a kind of hold upon the bladder, and maintain his communication with it. He now orders the staff to be withdrawn, and taking a pair of long straight forceps, introduces it by sliding the blades slowly and gradually along the palmar aspect of his finger, until they are fairly within the bladder. It is manifest that additional dilatation of the wound in the prostate must be made in this act; and it is important that the forceps should not be thrust in so as to form a rent in the soft tissues, but that the operator should slowly insinuate them in order to dilate gradually, and rupture as little as possible. Meantime a little of the urine will probably escape by the wound.

The mode of making the last or deep incision through the prostate and neck of the bladder demands special attention. It has been described here as made with the sharp-pointed knife employed in the earlier stage of the proceeding. Nevertheless, other means, and a great variety of instruments, have been, and are, still employed in its performance, for the purpose of attaining, as it is believed by some, more safety in making the incision. Two principles of construction, and two only, have been adopted in the numerous forms of knife, bistoury, or gorget, which have been invented from time to time in order to accomplish this end. The first principle has been to give the instrument, whatever its form and name, a blunt probe-point, which shall run easily along the groove of the staff, and be incapable of inflicting any wound. The other principle is that of giving to the blade of the cutting instrument such a width as to determine the exact depth of the incision intended; to ensure that this depth shall not depend on the hand or judgment of the surgeon at the moment of operating, but solely on the pre-arranged depth of the blade itself.

The instrument which illustrates the first class is the simple probe-pointed knife,

FIG. 60.—Sir William Blizard's Probe-pointed Knife.



or bistoury; one of the earliest and best-known forms being that of Sir William Blizard, whose name it still bears (fig. 60). This, or some other form of it, has been used by many operators in order to make the deep incision, on the alleged ground of

its superior safety to the sharp-pointed knife. But before exchanging his scalpel for this instrument the operator is careful that the urethra is freely cut, and he secures the opening with his finger-nail during the change. Provided this is accomplished, there is no possible objection to the use of the probe-pointed knife, and if an operator has a conviction that it is safer in his own hands than the sharp-pointed scalpel, he should certainly employ it.

For the numerous varieties of instrument, designated by the term *gorget*, which illustrate the second principle of construction referred to, the probe-point also is always employed. It is really a very old instrument, being one of the leading features of the 'Marian Operation'; it was used by Cheselden, and was reintroduced with some modification by Hawkins, and subsequently used by Cline, Green, Keith, and other.

To this same principle of construction belong the '*bistouries cachées*,' or lithotomes of all kinds (fig. 61)—*i.e.* the depth of the incision depends on the breadth of the instrument, and is therefore a result more of mechanical arrangement than of the intelligence and skill of the operator. The *bistourie cachée*, and the cutting-gorget, different as they are in appearance, and in the manner of their employment, are essentially the same in principle; the gorget cutting the desired depth inwards by pressure,

FIG. 61.—The Lithotome, or '*bistourie cachée*,' as used by many foreign surgeons to make the deep incision.



A, a screw which regulates the extent to which the blade protrudes from the sheath.

the lithotome cutting it outwards by traction. Blunt gorgets—that is, gorgets which have no pretensions to cut—are rather directors than gorgets in the sense in which we have been considering them. They are intended to dilate an *already divided* prostate, and to furnish a safe guide to the forceps in certain cases. I have myself often found this instrument useful where the prostate is large, and the perinæum deep, as in a very fat subject, and always include one among my instruments at a lithotomy operation.

The forceps being now within the bladder, one blade below on the floor, the other above, the instrument is opened freely by a handle lightly held in either hand; and as the urine flows out, the stone may be found between them on closing; if not, they are to be kept closed and slightly moved right and left, to ascertain on which side the stone lies. Supposing it can be felt lying on either side of the blades, the upper blade is raised, by simply depressing the handle, and when pretty widely separated, they are slowly turned over to that side and closed, when the stone will almost certainly be felt within the grasp of the instrument. If so, and the withdrawal feels easy, it is made at once, first rotating a little the forceps on its own axis to make sure that nothing else is included but the stone. If the angle of the handles indicates that the blades are wide apart, the point of the forefinger should be slid along the instrument to ascertain if possible the size and position of the stone, and readjust the latter. The long axis of the stone should correspond with that of the forceps, and its narrowest diameter should be presented to the blades. If the operator fails to seize the stone, he must still proceed cautiously, and avoid all rapid and plunging movements in the cavity of the bladder. And when the stone is fairly seized, the extraction must be slowly accomplished; the greatest amount of dilatation of the neck of the bladder has now to be made, and it is necessary to do it slowly and judiciously. The forceps must be held so firmly as to secure the stone, but not be grasped so as to crush it. They should be slowly moved from side to side while steady traction is made in the direction of the wound, and consequently in a line obliquely downwards towards the operator's right side. It is quite impossible to over-estimate the importance of slow and cautious action in this stage of the proceeding.

The stone removed a searcher should be passed into the bladder, and a gentle

exploration made, to ascertain whether other stones exist. The calculus itself may be examined for facets on its surface, which are almost always, but not invariably, indications that another is present. On the other hand, the absence of facets is not absolute proof that no other stones are in the bladder.

If the stone is found to be unduly large, so that, although grasped in the most favourable position for extraction which its form admits, the divergence of the blades proves to be too great, or is obviously so, for extraction through the wound, one of two courses, at least, remains to be adopted: either to enlarge the wound, or to crush the stone *in situ*. These alternatives, however, are rarely presented. Crushing *in situ*, with an empty bladder contracting on the calculus, is dangerous; but when the stone is too large to remove by any wound which it is prudent to make, this course is usually adopted. It has been successful with a stone weighing upwards of fourteen ounces. (See section on 'Accidents and Difficulties met with in Lithotomy.')

The flow of blood, which should be watched throughout, is now to be especially regarded before anything else is done. If an arterial jet is seen within reach, a ligature is to be used, or it may be arrested by torsion; if arterial bleeding is taking place freely from a deep part of the wound, its source must be carefully sought and ligatured if possible. It is very rare indeed that an arterial jet cannot be so commanded, if ordinary patience and skill are exercised. But if the ligature cannot be applied, we may use the ordinary gum-elastic tube fitted with a muslin petticoat (tube en chemise), and pack tightly round it some strips of lint to make pressure. Better still is the 'air-tampon' already described, which is introduced with the end of the tube fully an inch within the cavity of the bladder and then inflated, and left for 24, 36, or 48 hours, if necessary. With this instrument the operator may always feel safe: and indeed no one should ever perform lithotomy without one at his side. All provisions and directions relating to icebags, irrigation, &c., formerly described, are now unnecessary, since this is absolutely efficient if it be only properly applied.

Supposing there is merely a little general oozing from the wound, it is sufficient to inject a large syringeful or two of cold water through a long bulbous-ended tube into the bladder, from which it returns in a current, and then to introduce a simple gum-elastic tube about six or seven inches long, to prevent the inner portion of the wound becoming stopped by clot or otherwise, and producing retention of urine. The tube is fastened by tapes to a bandage round the patient's middle; but it is by no means often necessary. I have discarded it as a rule for years, and the wounds close better and more quickly in consequence, some indeed almost by the first intention.

After treatment.—The patient is to be placed on a firm, well-made mattress, guarded by waterproof cloth. A draw-sheet is to be placed beneath his buttocks, so that the wound and all that issues from it are clearly visible; and the window should face the foot of the bed. Each leg should lie on a pillow inclining outwards. The attendant will watch the flow of urine and the oozing of blood; and if the tube appears to be blocked, a feather must be passed through its entire length to ensure freedom of passage. Opium may be administered, and in a full dose, if there is much pain or restlessness; but it is better to do without it unless manifestly wanted. Cleanliness is of the greatest importance: the draw-sheets must be very frequently changed; the nates are to be kept clean by the occasional application of a soft moist sponge, and all sources of impurity are to be speedily removed. Mild, unstimulating diet, chiefly in the fluid form, such as milk and animal broths, should be freely afforded at first, until the stomach desires solid food, which may then at once be given. As the case progresses, care must be taken, especially with elderly patients, to avoid irritation of the skin of the back and buttocks, which, if neglected, might produce bed-sores. The surface is to be defended from the contact of urine by the free use of common ointment, and hardened by the occasional use of astringent lotion, or by spirit and water. A proper position of the patient is by no means unimportant as favouring the desired result: he should lie alternately on his right and left side for a few hours at a time, so as to change the direction of the urine and other discharges.

After the first twenty-four hours, the urine frequently passes two or three times by the urethra; after forty-eight hours it passes entirely through the wound.

Subsequently it may be expected, in the case of adults, to pass in part through the urethra by about the eighth to the twelfth day; and to cease issuing through the wound in about three weeks after operation. There is much difference, however, in this matter; many weeks elapsing in some instances before the final healing of the perineal wound, which, indeed, in some few instances, remains permanently fistulous; while in others healing really occurs by first intention—a result which may be sometimes favoured by treatment.

Key's modification.—Mr. Key's operation on the straight staff finds favour with many of his former pupils; and is still preferred by them, as it was by himself to the end of his career. The mode of performing it is given here in his own words, which clearly delineate the method he adopted, and which is followed at the present day by the surgeons of Guy's Hospital.

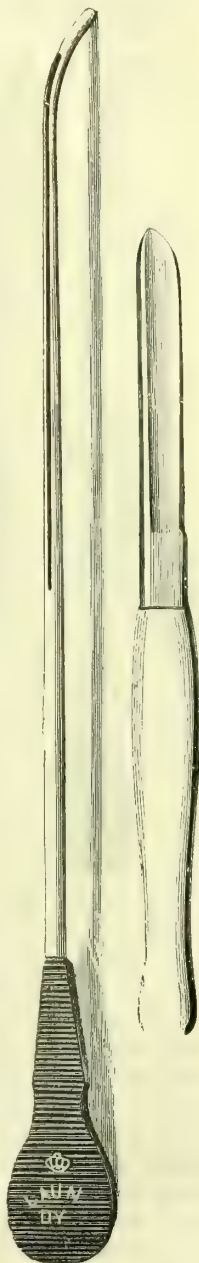
'The mode of conducting the operation is as follows: An assistant holding the director' (or straight staff, fig. 62) 'with the handle somewhat inclined towards the operator, the external incision of the usual extent is made with the knife (fig. 63), until the groove is opened, and the point of the knife rests fairly in the director, which can be readily ascertained by the sensation communicated; the point being kept steadily against the groove, the operator with his left hand takes the handle of the director, and lowers it till he brings the handle to the elevation described in Plate III.' (that is, until the sound makes an angle with the horizon of about thirty degrees), 'keeping his right hand fixed; then, with an easy simultaneous movement of both hands, the groove of the director and the edge of the knife are to be turned obliquely towards the patient's left side; the knife, having the proper bearing, is now ready for the section of the prostate; at this time the operator should look to the exact line the director takes, in order to carry the knife safely and slowly along the groove; which may now be done without any risk of the point slipping out. The knife may then be either withdrawn along the director, or the parts further dilated, according to the circumstances I have adverted to. Having delivered his knife to the assistant, the operator takes the staff in his right hand, and passing the forefinger of his left along the director through the opening in the prostate, withdraws the director, and, exchanging it for the forceps, passes the latter upon his finger into the cavity of the bladder.'

'In extracting the calculus, should the aperture in the prostate prove too small, and a great degree of violence be required to make it pass through the opening, it is advisable always to dilate with the knife, rather than expose the patient to the inevitable danger consequent upon laceration.'

Other modes of reaching the bladder besides that described as the 'lateral operation' have been devised by different surgeons to diminish the risks which it, or indeed any wound sufficiently large and deep for the purpose required, must necessarily expose the patient. The object has been to avoid wounding the bulb, or the arterial branch supplying it; to avoid also injuring the rectum, or too freely dividing the prostate. These modes will be briefly described, commencing with—

Dupuytren's bilateral operation (first performed in 1824). Having introduced a staff with a median groove, he made a crescentic incision above the anus with the horns of the crescent downwards. Each extremity reached

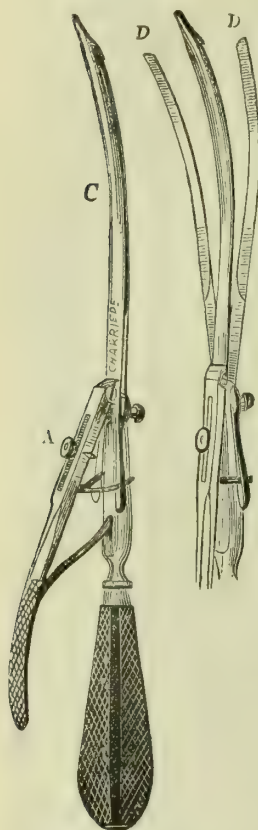
FIGS. 62 and 63.—
Key's Knife and
Staff (from his
work, plate iv.)



¹ *Treatise on Section of the Prostate Gland in Lithotomy* (by C. Aston Key. London, 1824), pp. 28–30.

midway between the anus and the adjacent tuber ischii, and the middle or highest point was distant from the anus about ten or twelve lines. By this incision the skin, the superficial fascia, and a little of the external sphincter were divided. In the next the membranous urethra was opened transversely so that into the groove of the staff might be slipped the end of a two-bladed lithotome.

FIG. 64. — The Double-bladed Lithotome, for the bilateral and medio-bilateral operations.



A, the screw which regulates the extent to which the blades open; C, the sheath with the blades enclosed; D D, the blades opened.

This was pushed onwards into the bladder, the stone felt with it, and the staff removed; the blades being then opened to an extent previously provided for, they were steadily withdrawn in the middle line and in the horizontal plane; thus a bilateral incision, nearly transverse, was made, involving the neck of the bladder and lateral lobes of the prostate. Fig. 64 shows the two-bladed lithotome which he employed.

The *medio-bilateral*.—This method is described by Civiale in his '*Parallèle*,¹ published in 1836. 'Being dissatisfied,' he says, 'with the results of the bilateral operation, and shunning the lateral method on account of the anatomical objections referred to,' he first practised a medio-bilateral method in 1829, and he performed it almost invariably afterwards.

His method was as follows: Having introduced a staff with a median groove firmly held against the pubes by an assistant, he made a vertical incision about an inch and a half long in the raphé of the perinæum, immediately in front of the anus, and carefully cut down in the direction of the staff, endeavouring to avoid the bulb, until he reached the membranous portion of the urethra. He then carried his knife into the staff in that situation, by an incision sufficiently large to enable him to insert with ease the end of a double-bladed lithotome, resembling that of Dupuytren, into the groove of the staff. He then pushed the beak of the lithotome steadily onwards into the bladder, and, having done so, drew it outwards in the groove, dividing the neck and the prostate horizontally, as just described. The external wound is oval in form, a vertical incision in the perinæum always becoming so; hence the skin is not cut transversely by the lithotome in the act of the withdrawal. The finger is now introduced, and the forceps upon or guided by it, in the usual way; the external and internal openings are felt to correspond, and to form an easy and direct route for the removal of the stone. The breadth of the internal or horizontal incision must correspond with the

size of the stone to be removed.

Median operation.—The operator having placed a staff with a median groove in the bladder, and given it to an assistant to maintain strictly in the middle line, places his left forefinger in the rectum, with its palmar surface upwards, to determine the apex of the prostate, placing the point of his finger upon it. He then transfixes, with a long straight bistoury, the cutting edge of which is upwards, the integuments of the perinæum, in the median line, commencing about half an inch anterior to the anus, and carries it steadily onwards until it enters the groove in the staff, and pierces the urethra about the membranous portion, the finger in the bowel rendering this manœuvre tolerably easy. Having pushed the point of the knife onwards towards the bladder for the extent of a few lines, so as just to incise the apex of the prostate, he cuts upwards, dividing the urethra a little, and making an external incision about an inch and a half long, according to the necessities of the case. He

¹ *Parallèle des Divers Moyens*, &c. (Paris, 1836), pp. 192, 217.

next introduces a ball-pointed probe through the wound into the bladder to serve as a guide for the left index-finger, which follows directly into the bladder, and the staff is at the same time withdrawn. The stone may now be felt, and the wound dilated by means of the finger, or by instruments for the purpose; as a rule it would mostly be safer to make an additional section when necessary. In making the incision, I prefer dissecting from the skin inwards to the staff, as in other operations, to the method by transfixion above described, and have usually done so, when operating as I formerly did and occasionally still do by the median method; maintaining the left forefinger in the rectum during the final strokes of the knife to feel its position, and ensure the safety of the bowel.

The incisions here described differ little from those of the Marian, the danger of which arose from the practice of forcibly rending asunder the urethra and neck of the bladder, a method more fatal than that by division with the knife.

Buchanan's operation.—This proceeding, generally known as the operation with the angular staff, is, however, not rendered distinctive solely by the use of that instrument. It is essentially a median and not a lateral operation, but with a freer internal opening than is provided in the former. The angular staff is intended to be a safe and efficient guide to the deep part to be incised, viz. the membranous urethra and apex of the prostate. Such a staff has been used a century or more ago in the lateral operation, a fact which detracts nothing from any merit which may attach to the present procedure.

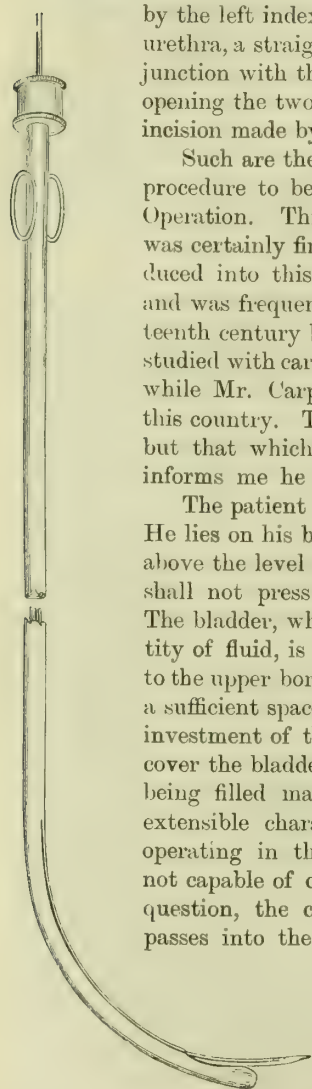
Impressed with what he believed to be the anatomical dangers of Lateral Lithotomy, Dr. Buchanan, of Glasgow, advocated in 1847 the mode of operating in the central part of the perinæum instead of the lateral, and of employing a staff of rectangular form, on which to make the necessary incisions. It may be briefly described as follows:—

Instead of possessing any curve, the terminal portion of the staff, three inches in length, is directed at a right angle to the shaft, and contains a deep lateral groove. This is introduced into the urethra, and by means of the left forefinger in the rectum the angle is made to correspond in situation with the apex of the prostate, so that the gland can be felt just beyond, between the finger and the staff; the latter being well depressed, the angle is brought near to the surface and is readily felt in the perinæum. The staff is then carefully maintained in this position by an assistant. The operator, keeping his finger still in the rectum, enters a long straight bistoury opposite the angle of the staff, immediately in front of the anus: the blade being horizontal and the edge directed to the left is pushed straight into and along the groove as far as to the stop at its extremity. He thus enters the bladder at once, taking care to keep the blade parallel with the horizontal or grooved portion of the staff throughout the whole of the thrust. Next he withdraws the bistoury slowly, but, as he does so, cuts outwards and downwards a distance rather more than equal to another breadth of his blade, and then directly downwards to the same extent, describing, in this manner, a curved line equal to about one-fourth of a circle round the upper and left side of the rectum (patient's left), in which his finger still remains. An external wound, surrounding the corresponding part of the anus, about one inch and a quarter in length, results from the operation. The knife is a long straight bistoury, about a quarter of an inch wide, with three inches of cutting edge, and the point sharp at the back as well as at the front, so as to penetrate with facility. Thus far it is, as expressed by Dr. Buchanan himself, about equal to the half of Dupuytren's Operation. If the stone is large, an incision is made on the right side of the prostate, which has the effect of converting the proceeding very nearly into the operation referred to.¹

¹ Dr. Corbet of Glasgow has added an external grooved director connected with the handle of this staff; after the introduction of the latter into the bladder, the point of the director has only to be pressed through the tissues into the angle of the staff, which it infallibly meets, and a route for the knife is made from the skin of the perinæum to the bladder (*Medical Times*, Dec. 16, 1858). Sir James Earle adopted the same system for Lateral Lithotomy. See a descriptive plate in his *Practical Observations*, 2nd edit. London, 1803.

Nélaton's prerectal operation.—This method, which is, perhaps, more employed in France than any other, may be thus described. The objects proposed are (1) to avoid wounding the bulb; (2) to open the urethra with precision at a certain point. The operator introduces his left forefinger into the anus to find the apex of the prostate and its relation with the anus; the staff having been previously introduced into the bladder. He then makes a curved incision, the middle of which is about half an inch in front of the anus, falling slightly on either side, in all about one and a half inch or more in length. A short incision in the line of the raphé should fall perpendicularly

FIG. 65.—
The 'Sonde
à dard.'



into the centre of the first made incision. He then dissects slowly and carefully along the sphincter of the anus, so as to detach downwards the anterior wall of the rectum and separate it from the bulb above, directed by the left index in the bowel. Arrived at the membranous part of the urethra, a straight, pointed bistoury is pushed into the urethra just at its junction with the prostate, entering the groove of the staff. Into this opening the two-bladed lithotome of Dupuytren is placed, and the double incision made by withdrawing it in the usual manner.¹

Such are the methods of performing perineal lithotomy. The next procedure to be considered is that known as the High or Suprapubic Operation. This appears to have been designed by Pierre Franco, and was certainly first performed by him in the year 1561. It was introduced into this country by Proby, at the close of the sixteenth century, and was frequently practised afterwards in the early part of the seventeenth century by Douglas, Cheselden, and others. Subsequently it was studied with care and frequently performed by the Souberbielles in France, while Mr. Carpué, who had witnessed their practice, advocated it in this country. There are two or three modes of performing the operation, but that which appears to me the most complete, and which Civiale informs me he has practised several times, is as follows:—

The patient is placed on a firm operating table of the usual height. He lies on his back, with the pelvis elevated at least four or five inches above the level of the loins and shoulders, so that the abdominal viscera shall not press on the bladder, but rather fall away backwards from it. The bladder, which should be capable of retaining a tolerably large quantity of fluid, is now to be injected to a full extent, so as to bring its apex to the upper border of the symphysis pubis, or above it. In this manner a sufficient space is obtained between the symphysis and the peritoneal investment of the anterior wall of the abdomen, where it quits it to cover the bladder. The limits of this interval admit of great extension, being filled mainly with cellular and fatty tissues of a very loose and extensible character, and this fact it is which furnishes the ground for operating in this situation. It follows, therefore, that if the bladder is not capable of considerable distension so as to rise into the interval in question, the case cannot be regarded as suitable. The surgeon now passes into the bladder the 'Sonde à dard' (fig. 65) (an instrument

having very much the form, size, and appearance of a large prostatic catheter), and by depressing its handle raises the point nearly to the level of the upper border of the symphysis. It contains within it a strong stylet with a cutting point, which latter is concealed close to the apex of the sound, and lies in its

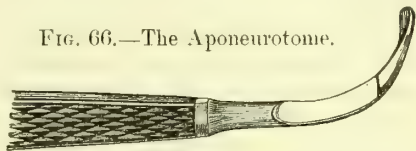
concavity, whence it can be made to emerge at the will of the operator. Having confided the 'sonde à dard' to an assistant, he places himself on the patient's

Mr. Avery contrived a very ingenious apparatus by which a director was forced outwards by mechanism from the angle of the staff after the latter had been securely placed in the bladder; when the point of the issuing director had made its appearance through the skin, the operator commenced to travel along its route into the bladder.

¹ *Elémens de Path. Chir.* tome v. pp. 229, 231.

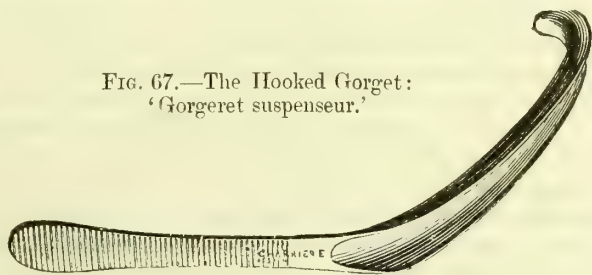
right side, and commences the incision above the pubes, which should be about three inches or more in length, according to the amount of fat at this spot, and which in some subjects is very abundant. It is to be made exactly in the median line, and at its lowest point should reach the top of the pubic symphysis. The cellular tissue and fat are divided to an equal extent, until the linea alba is recognised by its characteristic glistening appearance. Placing his left index-finger on this, and verifying through it the upper border of the symphysis, he divides with the scalpel the linea alba at this point, in the median line, from a quarter to three-eighths of an inch, and then introduces the bulbous extremity of the aponeurotome (fig. 66), which by its form enables the tendinous structures to be incised without any risk to the parts beneath. The division is accomplished by directing the aponeurotome upwards to the extent of one and three-quarters to two inches. The operator now takes the 'sonde à dard' from the hands of the assistant, who has hitherto

FIG. 66.—The Aponeurotome.



held it in its place; and with the right hand depresses its handle between the thighs of the patient, directing the point to the wound above the pubes. With his left hand he seeks the end, now readily to be felt through the tissues still remaining uncut, and fixes it between the thumb, index, and middle finger, taking care while doing so to remember that it is from the concave surface that the point will be protruded. Having rendered the instrument quite firm between his two hands, he directs the assistant to press the handle of the stylet so that the point issues from its place for two or three inches, and appears in the wound immediately above the symphysis. A communication with the bladder is thus perfectly established. The surgeon now takes an ordinary scalpel, and placing it in a groove existing for that purpose in the stylet, cuts downwards from the point of transfixion nearly to the neck of the bladder behind the symphysis. His forefinger is then applied, with its palmar surface upwards, to the top of the wound, to hook up the bladder, while the assistant withdraws the 'sonde à dard,' having first replaced the stylet in its sheath. An instrument called the 'Gorgetet suspenseur' (fig. 67), but which we may term the hooked gorget, now replaces the finger, and is committed to an assistant standing on the left side of the patient. It is very important to maintain the top of the bladder steadily in place throughout

FIG. 67.—The Hooked Gorget: 'Gorgetet suspenseur.'



all subsequent movements, and that the peritonæum, which is quite close to the wound at this point, should be preserved from injury. The surgeon now searches the interior of the bladder with his fingers, ascertaining the position and size of the stone, and introduces the forceps for its removal, which is generally tolerably easy, and may be effected by careful traction upwards and backwards. In a few cases with stones of large size the fascia may be divided laterally to a small extent in order to afford additional space. I found this necessary in a case in which I operated, that of a gentleman aged sixty-seven, for a large, rather flat, uric-acid stone, in 1877.

After the operation, I think it is useful to place a vulcanised india-rubber catheter in the bladder by the wound, leaving it there; more especially if, as in the case just named, the patient was unable to pass urine by the urethra, owing to enlarged prostate, except by catheter.

Dr. Murray Humphry of Cambridge, who has himself operated by this method, collected from various sources, English and foreign, 104 cases, in which 31 were fatal—a mortality of nearly one in three cases. Of late a proposal has been made to adopt supra-pubic lithotomy as the rule in the place of all other methods, on the ground that the former is capable of being practised under complete antiseptic

conditions, which is not possible with lateral lithotomy. But the rarity of septicæmia as a sequence of lateral lithotomy, as has been pointed out by myself,¹ militates strongly against the general application of an operation fitted only for unusually large calculi, and especially when small ones can be extracted by lithotritry with the almost absolute certainty of a successful result.

The recto-vesical operation.—The patient is placed in the usual position, and a large staff with a median groove held firmly in the middle line. Taking a strong, straight, sharp-pointed bistoury in his right hand, the operator introduces it flat on the palmar surface of his left forefinger into the rectum, and feels with its tip the line of the staff. When about an inch and a half or an inch and three-quarters of the blade is concealed within the bowel, with the right hand he raises its edge, and carries the knife upwards to the groove in the staff, propelling the blade at the same time with the left forefinger. He thus divides, at the first incision, the upper wall of the rectum, the sphincter ani, and the integuments and subjacent tissues for about an inch in the middle line of the perinæum. He should reach the groove of the staff in this first incision, and, having done so, he next directs the nail of the left forefinger, so as to enter the groove near to the membranous urethra, and guide the point of the bistoury into it there, the edge being now downwards. Having securely placed it in the groove, he pushes the blade from him along the staff, directed by the left forefinger, dividing the prostate and neck of the bladder so as to reach the trigone. The exact extent of this incision must depend on the size of the stone, and, as it may be presumed that this method should be employed only when the stone is unusually large, the incisions must of course be free. In no case, however, is it permissible to place in danger the peritoneal pouch, which limits the posterior border of the trigone. The finger can now easily examine the stone and guide the forceps in the extraction. The wound is favourably placed as an outlet for all discharges, and no hæmorrhage need be feared.

There are some variations in the manner of performing this operation, but the foregoing is the mode which has generally been regarded as the most successful, and the most likely to be free from disagreeable after-consequences.

Nevertheless, the recto-vesical operation must be regarded as a nearly obsolete procedure; the possibility of meeting with an example of calculus too large to be extracted by means of crushing forceps, and the extended excisions, which the other regions permit, must be extremely rare, if indeed it is to be admitted at all.

We may in this place briefly treat of certain attempts which have been made by several surgeons, both English and French, to combine cutting and crushing, so as to empty the bladder at one operation. The object has been, first, to open the urethra in the perinæum, anterior to the prostate; a proceeding which we know involves very little, if any, risk; and then to introduce a crushing instrument, break up thoroughly the stone, and remove the débris at once. If the incisions are rather extended, the operation is lithotomy with fragmentation of the stone; if the incisions are small, and the stone is much crushed, it is rather lithotritry by a perinæal opening. It is this latter method which Dolbeau of Paris has pursued, testing the result perhaps more completely than any other surgeon. His operation, which he termed 'perinæal lithotritry,' was thus performed by him: He first made a median incision on the raphé, opening the urethra, and involving it only in the membranous, and perhaps in the prostatic portions, through which he dilated the neck of the bladder, gradually but forcibly, by means of an expanding steel dilator. Next, he introduced powerful forceps to crush the stone extracting the débris through the wound. But there can be no doubt that what was supposed to be 'dilatation' of the neck of the bladder by the steel instrument produced a serious amount of rupture, and that without this little or no extra space could be gained. But serious risks may be also incurred by much manipulation for the purpose of removing débris in an empty bladder, as most lithotomists have observed when a large stone has chanced to break in the process of extraction. For it is a fact of practical importance that the act of pushing forceps upwards through a perinæal opening into an empty bladder in order to seize

¹ *Trans. Roy. Med.-Chir. Soc.* 1878, vol. lxi. p. 159.

fragments is more likely to injure the bladder than the act of seizing them with a lithotrite introduced downwards by the urethra into an unopened bladder. Hence, it has been proposed to break a large stone into fragments by means of a powerful lithotrite through the urethra before performing lithotomy, the incisions for which will then be less extended than if the stone is to be removed entire. In any case where the stone weighs three ounces or more the operator should be provided with powerful forceps with screw power in the handle, so as to be able to remove fragments rather than make deep internal incisions.

There is, however, an exceptional condition in which lithotrity and a median perineal incision may be advantageously combined. When the patient with a large stone can pass no urine except by catheter, the frequent use of the instrument after lithotrity is often almost unendurable. In these circumstances I obtained an admirable result by removing all the calculus at one sitting, after which I made a small opening into the urethra by the perinaeum and inserted a large catheter there. The latter can be borne with great ease, when the inlying catheter occupying the entire urethra is insupportable.

Lithotomy as applied to children.—In considering the various methods hitherto described, the common practice has been followed of assuming an adult to be the subject of the operation in each instance. And there is little occasion to modify them for the cases of children, the same procedures being applicable, for the most part, at all ages. Nevertheless, there are certain points of importance to be attended to in the application of lithotomy to children, which will be briefly mentioned here.

First, as to the kind of operation most generally applicable to the cases of infants and boys: the lateral is generally, and no doubt correctly, held to maintain its superiority, as a rule, over other methods. The median and the medio-bilateral are both admissible. But, especially where the stone is large, the lateral operation affords the opportunity of making a freer opening, and in a direction in which the incision is less liable than that of the median to injure the seminal ducts. At the same time, a lateral section carried beyond the limits of the prostate, which is an extremely small organ at this period of life, is free from danger, since it is beyond all question necessarily practised in almost all infantile cases, while the death-rate among them is not more than half what it is in adult age, at which time such sections, it is commonly believed, are extremely dangerous.

In the performance of lateral lithotomy in children, the employment of one knife only is especially indicated. An exchange of the scalpel for the beaked knife exposes to some risk from the possibility of finding difficulty in the attempt to place the beak of a second knife in the opening made by the first, and thus of missing the groove of the staff altogether. The deep incision in the urethra and prostate should be made with clearness and decision, and with sufficient freedom to admit the tip of the operator's index-finger with tolerable ease, otherwise he may drive the neck of the bladder along the staff, or slide the finger into the cellular interval between the bladder and the rectum. The staff should be strongly curved, and the finger and the forceps should be kept well up behind the symphysis in their transit, in consequence of the high situation of the bladder, which, in very young children, lies, when distended, as much in the abdomen as in the pelvis.

Hæmorrhage should be carefully guarded against, as its results in the shape of exhaustion are particularly dangerous in young subjects. The special sources of difficulty and danger in this operation will be considered when treating of 'Accidents and Difficulties met with in Lithotomy.'

If the median operation is performed, it is desirable to use a guide into the bladder in the shape of a blunt gorget or some similar instrument, as the operator may find it extremely difficult to introduce the finger into the small urethra of a child, when opened anterior to the prostatic or membranous portions. For this purpose I used with advantage, three or four years ago, an instrument of that kind, tapering in its contour, and having a probe point in its central axis. Mr. Bowman, and Mr. Teale also, about the same time, employed somewhat similar means for meeting the difficulty referred to, which each had encountered. Fig. 55 presents

one of the forms of gorget well adapted for the purpose, when made of the small size suitable for children (see page 258). By the use of any of these instruments the incised opening into the urethra is partly dilated and partly torn—a proceeding which appears to be attended by no evil results in children, whatever may be its effects in the adult patient. In the medio-bilateral operation, which I have employed in the young subject, no such guide, of course, is necessary. The two-bladed lithotome glides easily along the staff into the bladder, and forms sufficient room for the finger in its withdrawal by laterally incising the soft parts.

Accidents and difficulties met with in lithotomy.—These will be treated in connection with the perinaeal operations: no special remarks relating to supra-pubic and recto-vesical lithotomy being necessary.

The first accident to be named is that of wounding the rectum. It may occur when the incision commences too low down in the region, within an inch above the anus, especially if the knife is entered close to the raphé, from which, in this situation, it ought to be from three to four eighths of an inch distant. It is usually avoided, if the knife be held obliquely, and care be taken to guard the bowel with the left hand, unless the former is unusually capacious, or is distended with faeces, as may happen when the preliminary enema has not acted before the patient is placed on the table. The accident may take place in the first or in the second incision; and it is more likely to happen if the operator makes a deep thrust at his first incision, with the view of reaching the staff at once; but if the first incision is carried only through the skin into the cellular interval, and the finger be used to separate the tissues and feel for the staff, before the knife is again employed, the risk of injury to the bowel is less. When a small wound of the bowel has been made, no notice need be taken of it; if it is considerable, most authorities have advised that it should be laid open through the margin of the bowel and sphincter; but the necessity for this proceeding is by no means proved. I believe it is better to leave the parts untouched, and to reserve division of the sphincter until necessity for it appears from the non-cicatrization of the wound, as such cases have been known to recover soundly when not interfered with. At worst, usually, a small urethro-rectal fistula remains, which may be obliterated by the introduction of a heated wire, the bladder being first emptied and a vaginal duckbill speculum placed in the rectum. I believe no operator can perform lateral lithotomy on many elderly patients, in whom the rectum is sometimes enormously capacious, without sometimes making an opening into the bowel. I have had three cases myself among my numerous lithotomies, at upwards of sixty years of age, and think it right to state this fact. Sometimes sloughing of the thin septum between the wound and the rectum will take place, when no wound of the bowel was originally made, and an opening may appear ten or fourteen days subsequently. Of this I have certainly seen two examples.

The removal of a small portion of the prostate gland by laceration, or otherwise, is not a very uncommon accident with elderly patients. It may occur in two different ways: first, it sometimes happens that the section of the prostate exposes one of those small rounded tumours which are so frequently embedded in the substance of the prostate in elderly patients; under which circumstances the tumour becomes easily enucleated. Secondly, an outgrowth, more or less projecting from the prostate into the vesical cavity, may be caught between the blades of the forceps when seizing the stone, and be torn off in the act of removing it. I have myself witnessed this accident, and have several times removed such a tumour myself, and in no one of the cases did it endanger life.¹ Dr. Keith informed me that he has met with it nine or ten times, and he was not aware that material injury resulted in any instance. Mr. Key made a similar observation.²

It is occasionally discovered within a few days after the operation that one or

¹ I had the opportunity of exhibiting, at the Pathological Society of London, three tumours of this kind, weighing five scruples, removed from a patient the subject of two large stones, who recovered.—*Path. Trans.* vol. xiii. p. 155.

² 'Remarks on the Lateral Operation of Lithotomy,' *Guy's Hospital Reports*, 1837, p. 23.

more calculi, or fragments of calculus, remain unextracted. This is a serious accident and ought very rarely to happen, although, from unavoidable circumstances, it may occur to the most experienced operators. The course to be adopted must depend, in some measure, on the condition of the patient. When only small fragments are present, they will frequently pass spontaneously by the wound. If otherwise, and the patient is in course of recovery, and his prospects are good, the first step is to ascertain precisely the size of the fragments or calculus remaining. This may be done by a lithotrite, and, if not large, the fragment or calculus can be crushed and removed at once. If it is of rather large size, it is quite easy within a fortnight of the original operation to dilate the wound, and remove the foreign body with the forceps. I have done this once only in a case of my own, and I have assisted a brother surgeon once in similar circumstances. Each case was operated on the second time about nine or ten days after the first, and each made a good though a slower recovery than usual.

Phosphatic incrustation coating the wound after lithotomy is sometimes very troublesome. It occurs between the seventh and fourteenth day after, or thereabout. When slight, a few hip-baths, or washing with warm or acidulated water, will remove it. Once or twice I have found it so thick and so extensively deposited, as to be obliged to remove it by the forceps. In one case it coated the whole track of the wound, from the perinæum to the neck of the bladder, and from the internal extremity a small calculus was formed in the bladder itself, and was crushed by me before the end of the fourth week. The wound was some months in healing, but did so at last, and the patient is at this moment in excellent health.

Secondary hæmorrhage.—The hæmorrhage occurring at, or immediately after, the operation has been considered in describing the operation. But it is sometimes secondary, taking place at a period of seven to ten, or even fifteen, days after the event, and it is an accident which no foresight could have prevented. Four cases have occurred in my own practice, in two with a fatal result, and in circumstances which, had it not happened, there was every reason to expect a successful issue to the case. One was a case of medio-bilateral lithotomy. The other occurred in a gentleman aged 55, quite suddenly and unexpectedly, on the twelfth day after a lateral operation. When it is controllable by the ligature, no means is so safe and certain; but such a result is not to be expected, since the external wound has generally by this time become small. The finger should be introduced, to ascertain whether by pressure with its point the source of bleeding can be stopped; if so a piece of lint attached to a probe, or stick, and dipped in a solution of the perchloride of iron, should be applied to the spot. Sometimes the actual cautery has been found effectual. Were a case to occur to me now, I should open up the wound and at once insert the air tampon (described page 259) and I do not doubt it would suffice to arrest the hæmorrhage.

Occasionally the wound which is produced by the operation heals very slowly, and results in the persistence of a fistulous track from the prostatic urethra to the perinæum. If no calculous matter exists in the track, the whole internal surface of the fistula should be lightly touched with the galvanic cautery. After this the patient, having previously learned to do it with facility, should withdraw all his urine for three or four weeks by catheter, provided he can accomplish it easily, so as to prevent any flow through the fistulous channel. By a perseverance in this plan success may be obtained in most cases.

A very unusual result of the lateral operation is sexual impotence. This condition has been attributed to the division of the seminal duct which lies nearest to the line of incision. There is good reason, I think, to doubt the correctness of this supposition; for the line of incision ought never to intersect the duct even on the side operated on; the knife must be carried almost vertically downward in order to endanger it; indeed, if it be employed with even a less degree of obliquity than has been previously advised, the vessel will still be safe. When loss of virile power occurs, it is generally due either to sloughing from violence or to inflammatory action in and around the ducts and vesiculæ seminales, destroying the function of

these organs, and not to the mechanical division of one or both of them by the knife.

Some incontinence of urine occasionally follows the operation. It occurs more frequently in patients below the age of puberty than in adults. Apart from those rare instances of extremely large stone in which the neck of the bladder has been extensively damaged, no very clear explanation of the cause can be afforded, although speculative statements respecting it have been frequently made. Nor, perhaps, is it possible to offer any therapeutical considerations relative to it, differing from those which are available for incontinence occurring in ordinary cases. I have, however, seen it disappear in one case after applying caustic to the neck of the bladder.

An unfortunate accident still remains to be noticed, viz. inability to discover any stone in the bladder when the operation has been performed.

In the first place, the stone may not be found because it is so small as to be washed out with the first gush of urine from the bladder. I have seen lithotomy performed for a stone no larger than an apple-pip, and much embarrassment caused by the occurrence named. It has happened that, after a long and fruitless search in the bladder, a small concretion has been found on the floor, or in the receptacle placed to receive the blood and urine, or embedded in a clot, or even adhering to some part of the operator's dress. But this ought not to happen, mainly because cases in which the calculus is so minute should not be subjected to lithotomy at all. Again, an operation may prove fruitless because the stone is fixed in a cyst of the bladder, and cannot be detached from its place. (See remarks on 'Encysted Calculus.') And no stone may be found at the operation, because none has ever existed. The surgeon may have sounded his patient and believed him to be the subject of calculus, and yet no stone whatever may have been present. Thus, the existence of a polypoid tumour in the bladder, probably with some calculous deposit adhering to its surface, has deceived the surgeon. Such a case was many years ago cut for stone; the preparation is now in the Museum of St. Thomas's Hospital.¹ It has also happened that a rugose condition of the coat of a hypertrophied bladder has misled the surgeon, when sounding, into the belief that he has struck a stone. The bony walls of the pelvis particularly, according to some authorities, may furnish similarly erroneous impressions to the operator. But in both these circumstances, the tactile impression and the audible sound are dull and heavy, not so clear and defined as the metallic click of a stone. Yet the fact exists that highly experienced and able surgeons have been misled by one or other of these causes.² Mr. Paget of Leicester recorded the particulars of an instance in which he operated on a child without discovering stone: the click, although heard by several, was not distinct on any of the occasions of sounding which had taken place, while the symptoms were exceedingly severe. The operator, however, desired to relieve the sufferer if it were possible, hoping that a partially encysted stone might be the cause. Death occurred after two days, and at the post-mortem examination no calculous matter was found in the bladder, but the ureters were enormously dilated. On repeating the act of sounding, the click was reproduced, and it was discovered to be due to the point of the sound impinging upon the iliac portion of the brim of the pelvis, the edge of which was unusually thin and sharp.³ This opinion was confirmed by the experience of Mr. Gutteridge of Birmingham, who operated in three cases where he had carefully sounded, and found no stone; and the operator came to the same conclusion in relation to the cause of deception.⁴ I have never met with such a case myself; but am quite certain that great care, especially in the cases of young children, must sometimes be exercised, for the purpose of determining the existence or not of a small stone. I have found it necessary to repeat the sounding when the result of the first examination was uncertain in these young subjects.

¹ South's *Chelius*, vol. ii. p. 551.

² Cheselden, Roux, Dupuytren, and Crosse have operated and failed to find the stone.

³ *Brit. Med. Journal*, Dec. 14, 1861.

⁴ A memoir on the subject, published by Mr. Gutteridge, Sept. 1860.

Difficulties met with in the operation.—When the subject is in advanced age, the neck of the bladder is sometimes rigid and unyielding; and sometimes the prostate is unusually large. The first-named condition is quite distinct from the latter, and may exist in complete absence of enlargement. In a marked case, when the finger is introduced dilatation is not perceived, as in ordinary cases, to take place; when the forceps are introduced, the same thing is felt, and a tear occurs if any force be applied. Either laceration or extended incision must follow or the stone cannot be removed, unless indeed the calculus be broken up and its removal be attempted piecemeal. Probably it may be better to reapply the knife to a limited extent, rather than to risk the uncertain amount of laceration which must follow extraction by the forceps. These cases, which are happily rare, although their occurrence has been recognised by all experienced operators, seldom are successful.

Relative to enlarged prostate, I am less disposed, however, to rank it high in the scale either of difficulty or of danger. It sometimes prevents the forefinger from entering the bladder; it increases the distance between the operator and the stone, and thus augments the difficulty of seizing and extracting it; and it does the same by placing the stone in a disadvantageous position, that is, lying deeply behind the neck. On the other hand, deep internal incisions in an enlarged prostate are comparatively free from danger, and there is no fear of reaching its external limit. The gorget is an efficient instrument in these cases for extending the deep incision; it forms a conductor for the forceps into the bladder when the finger cannot reach it, and keeps projecting tumours out of the blades, which might otherwise be lacerated, or brought away in their grasp. When the stone lies deeply behind an enlarged prostate, the curved forceps may be useful, although I have rarely found more than one pair of straight forceps necessary in any case. Sometimes the stone may be brought into good position for extraction by placing one or two fingers in the rectum, and raising the stone towards the level of the internal wound.

In elderly subjects, also, it occasionally happens that the bladder has become atonied, not having been able to empty itself for a long period of time. In the gush of water outwards, the bladder collapses rather than contracts, and the stone may be enveloped in folds of the organ, a circumstance sometimes occasioning trouble. Careful manipulation of the forceps, or of the scoop, with pressure by an assistant on the hypogastric region, will aid the surgeon to remove it. In these cases, however, it appears to be wiser to operate with a nearly empty bladder than a full one; the stone is then more likely to be found at the neck, close to the internal incision.

The bladder is sometimes more deeply placed as regards the surface than occurs in ordinary cases; and this commonly when the patient is exceedingly stout, the layer of fat in the perineum adding very materially to the distance between the surface and the bladder. In this case it is necessary to make the external incision longer in proportion at both extremities, or the wound will be too narrow in proportion to its depth, and especially if the stone be a large one. The remarks just made respecting the use of the blunt gorget apply here also.

Another difficulty is presented by the unduly narrow pelvis. The pelvic outlet may be congenitally contracted, or it may be deformed by rickets. An example of this in the case of a boy has occurred to myself. There was a large stone, and having made the incision by the lateral method, I found unusual difficulty in extraction, which, however, I safely accomplished after a little delay. Ultimately the child died; and at the autopsy the pelvis was removed: there was so much distortion, due to rickets, that the antero-posterior diameter measured only seven-eighths of an inch, on the dry specimen; while the calculus was almost three-quarters of an inch thick, being one inch and an eighth long, and seven-eighths of an inch broad. Had this condition been discovered beforehand, no doubt the supra-pubic operation might have been performed with advantage.¹ Sir Astley Cooper speaks of a case in which Clive

¹ *Med.-Chir. Trans.* vol. xlvii., with a drawing of the pelvis and of the stone.

found the ischia so abnormally approximated, that, having introduced the forceps and seized the stone, he was unable to withdraw, and consequently broke it and removed the fragments separately.¹ Another case observed, but not operated upon, is recorded by Mr. Bransby Cooper.²

Other difficulties are—the unusual distribution of the vessels, rendering serious hæmorrhage unavoidable; the existence of the hæmorrhagic diathesis; the presence of organic disease in the kidneys or elsewhere; of extremely nervous or irritable temperament; of plethora, obesity and debility combined—a not uncommon, but most unpromising condition; and, lastly, of great exhaustion from long-continued suffering.

A formidable and generally recognised difficulty is that of unusual size in the stone. Other things being equal, both danger and difficulty may be said to arise in direct proportion to the magnitude of the body to be removed. Hence unusual modes of dealing with large calculi have been proposed by different surgeons from a very early period in the history of lithotomy, and instruments for the purpose were adopted even before the time of Celsus, who refers to the practice.³ Ambrose Paré describes his improved forceps, with screw-power in the handles, in order to crush the stone before removing it.⁴ Le Cat modified them, and invented an instrument for perforating the stone also; his instruments, especially those with which he made the incisions, were extremely complicated.⁵ Of late years numerous attempts have been made to improve these instruments, commencing with those of Mr. Earle.⁶ A combination of forceps with a powerful drill was used by Civiale for a few very large calculi.

For the removal of extremely large stones, weighing from three to five or more ounces, the choice rests, perhaps, between lateral lithotomy with this adjunct, and the High operation. The great source of difficulty and danger is the empty state of the bladder, scarcely realised perhaps by those who have merely made or designed instruments for reducing the stone to fragments,⁷ after the incisions have been completed. Still, in comparing the dangers arising from prolonged manipulations in order to break up a large calculus and withdraw its fragments through the wound, with the risk of extended incisions on both sides of the prostate gland, in order to remove the calculus entire, I may say that I incline to the former procedure. I never perform the lateral operation (employing it, of course, only as a rule for the largest stones) without a powerful forceps with screw power in the handles; and these I have twice recently employed for stones of about three ounces or a little more in weight. It should be named also, that for such cases another course is still open, viz. to introduce a powerful lithotrite before the incisions are made, and while there is still fluid in the bladder, and break the stone once or twice so as to divide it into a few fragments, which may then be withdrawn through a wound of ordinary dimensions. And this method is, I think, fairly applicable, and perhaps with advantage, up to a weight in uric acid of four ounces. Such calculi, however, are now very rare, and, with increasing knowledge and vigilance on the part of medical men, must soon almost inevitably cease to be produced.

There is a practical point of importance to be noticed in connection with very large stones, viz. the very slight evidence of their presence which is obtained by sounding in certain cases. I have myself found, in sounding a patient whose bladder was filled with hard calculus of enormous size, that it was difficult to elicit a note, because of the inability, from want of space, to strike, however slightly, the foreign body. Covered closely by the walls of the bladder, and itself coated with mucus,

¹ *Lectures on Principles and Practice of Surgery*, by B. B. Cooper. London, 1851, p. 601.

² *Op. cit.* p. 599.

³ Celsus, *De Medicinâ*, lib. vii. cap. 26. ⁴ Paré's *Works*, lib. xvii. cap. 42.

⁵ *Parallèle de la Taille latérale*. 1766. See plates and descriptions at the end.

⁶ *Méd.-Chir. Trans.* vol. xi. 1821. With a plate.

⁷ I employ the words 'fragmentation' and 'fragments' to indicate the breaking up of a stone into a few large pieces in connection with lithotomy, reserving the words 'crush' and 'débris' as describing the process and result which are attained through a lithotrite.

only an indistinct grating could be felt, although it subsequently proved to weigh twelve and a half ounces; and is the largest specimen in my private cabinet. The late Mr. Crichton of Dundee, whose experience of large stones was considerable, called special attention to this source of error in sounding.

Others characters of the stone causing difficulty to the operator are unusual form and extreme brittleness. A long stone, and a thin, flat stone, are difficult to remove, and require careful adjustment in the forceps, or the aid of the scoop, before attempting to extract. Large round tuberculated stones are also formidable, and for equal weights are obviously much more so than smooth oval stones. A stone, also, which easily crumbles into fragments is always a source of trouble and anxiety; making much instrumental manipulation necessary; and the fear of leaving a fragment behind is always present. Similarly, multiple calculi are sources of some difficulty, although less so than are numerous fragments. Instances of two, three, or four calculi are common. I have removed upwards of eighty from a single bladder.

The unusual situation of a calculus may be a source of difficulty and embarrassment. Sometimes calculi becomes encysted in the bladder; although not so often as some statements would lead us to infer. But we have anatomical evidence that calculus may be either altogether or only incompletely contained in a cyst in the bladder, a small part of its surface being exposed at the mouth of the cyst.

It is not uncommon, when the latter condition occurs, that fresh calculous matter is added, little by little, to the exposed surface, so that, in process of time, a calculus is formed, protruding into the bladder, in which situation it increases in size; a narrow neck exists uniting the vesical to the encysted portion, and the whole acquires a form somewhat resembling that of an hour-glass. Sometimes the vesical portion breaks off, and a free stone in the bladder is the result.

Dr. Murray Humphry of Cambridge has recorded a very complete illustration of this condition,¹ in which he removed no less than four times by lithotomy a stone thus produced. On a subsequent occasion, he succeeded in removing a large encysted stone by the recto-vesical operation, but the patient died with peritonitis.

I exhibited at the Pathological Society, in 1861, for Mr. Cadge, of Norwich, a specimen of encysted calculus, removed by him during life with a portion of the cyst adhering, like a collar to the neck, uniting the two portions, and the patient recovered.² Two such cases occurred in Mr. Crichton's practice, who minutely describes his proceedings in the MS. notes; one case in 1842, one in 1844. In all three cases the stone was situated near the neck of the bladder, and in the two latter on the right side. Mr. Crichton says of each patient that he observed, when sounding (which he repeated two or three times, the signs being rather indistinct), that the stone seemed always to be fixed at the right side of the bladder. He writes: 'The bladder was cut into, and the presenting portion of the stone laid hold of by the forceps and quickly extracted, broken off at the neck; a grooved director was then introduced into the bladder, and insinuated between the edge of the sac and the encysted portion of the stone, which, by a little perseverance, was so much raised from its confinement as to allow the forceps to get a hold, and another portion broken off and extracted. This was several times repeated till the whole was brought away.'

I have operated in two such cases by lithotomy. In the first, a gentleman, aged 74, in May 1869, I extracted a large phosphatic stone with loose fragments, and then felt a rough surface which I was able just to reach with my finger, near the neck of the bladder, and quite immovable; this surface was surrounded by mucous membrane, and a large mass was clearly outside the cavity of the bladder. Placing the other index-finger in the rectum, I encountered

¹ *Report of some Cases of Operation*, by G. M. Humphry, M.D., F.R.C.S., Surgeon to Addenbrooke's Hospital, Cambridge. London, 1856.

² *Trans. Path. Soc.* vol. xii. p. 136. I exhibited a case of my own also (post-mortem); see vol. xii. p. 138.

a hard tumour, corresponding to that felt in the bladder, and movable between the fingers of each hand. I endeavoured to remove it, but ineffectually, for it was too deeply embedded to be displaced, except by unjustifiable violence, and I was compelled to be content with emptying the cavity of the bladder. The patient was aged and feeble, and sank in about a month. At the autopsy the condition described was discovered, and I possess now the soft parts, showing the sac filled by auric-acid stone of the size described.

The second case occurred in the bladder of a woman aged 52; there I could not only verify the exact condition, but could also deal with it successfully. I operated in July 1874; Mr. Clover gave her chloroform. I introduced a lithotrite, intending to crush, but failed to seize and dislodge the stone from the left side of the bladder, where it appeared to be fixed. Withdrawing the instrument, I dilated the urethra with my finger, and found a calculus of which one-third appeared to be in the bladder, and about two-thirds in a sac outside the cavity of the bladder; these conditions were verified by my assistant, Mr. Forster, and by Mr. Clover, the only persons present. Reintroducing my finger, I insinuated my nail within the margin of the sac, and in about two minutes, by carefully working the finger round the stone, succeeded in turning it out of its bed, entire, into the cavity of the bladder, whence it was readily removed by the forceps after a slight incision of the urethra. She made an excellent recovery, and is now living and in good health. The calculus, which is in my cabinet, is in form something like a kidney, but with a deeper indentation, showing the line of the neck of the sac. An outline of the stone is presented at fig. 68.



More recently still I saw a case with Mr. Savory, in a gentleman of eighty years of age, in which with great difficulty we succeeded, by the use of small lithotrites, in extracting a smallish calculus which was sacculated near the neck of the bladder. Every portion was thus removed from the interior of the sac in five sittings. The rarity of such occurrences is, however, demonstrated from the fact that few operators meet with more than one or two cases in a lifetime. Deschamps and Brodie each record but one case.

Sometimes a little embarrassment is occasioned to the surgeon by his discovery that the calculus is more superficially placed in the perineum than he expected; on his encountering it, in fact, before arriving at the bladder. A vesical calculus may be found occupying partly the bladder and partly the prostatic urethra; or two or more independent calculi, locked together, and fitting to each other with polished facets, may be thus placed. It is necessary, of course, to remove that which first presents, after which there is usually not much difficulty in extracting the rest. Indeed, the whole calculus or calculi may be outside the bladder lodged in a sac which has some communication with the urethra, so that urine finds its way, more or less, into the interior of the sac. I have operated on two cases of this description, and others are on record; specimens may be found in the Hunterian Museum.

Spasmodic contraction of the bladder, rendering the removal of the stone difficult, is described by some high authorities as distinct from the condition which is present when the bladder has been merely emptied of urine, and therefore somewhat closely surrounds the stone.

It will probably disappear under the influence of anaesthesia. Sometimes the stone is lodged in the upper part of the bladder behind the pubic symphysis; this may be due to the spasmodic contraction just alluded to, but more generally, I believe, to peculiarity arising from hypertrophic thickening of the coats. The stone is habitually lodged there, and the coats are thickened, partly also by inflammatory deposit into their structure, impairing their power to dilate or contract. Here pressure above the pubes, firmly maintained by an assistant, will enable the operator to dislodge the stone.

It is not very uncommon to hear of operations in which the stone is said to have been found adherent to the bladder. But evidence resting solely on the sensations of the operator does not suffice to establish the fact, since difficulty in its removal often suggests the existence of organic connection between the bladder

and the foreign body. A few examples of what may be rarely seen to take place in the subject are appended in a note below, two of them having been examined by myself.¹

The bladder is, although very rarely, coated with a layer of adhering calculous matter, and this is one of the forms of 'adherent calculus' that anatomical researches have produced. In the Hunterian Museum, Prep. No. 2024, the mucous membrane is seen studded with small calculi, partially embedded in minute sacculi; but between the calculi the mucous membrane is covered with a thin layer of calculus material; at least half the inner surface is thus coated. No. 2025 exhibits a similar appearance; and in No. 2023, the prostate has an enlarged median lobe, similarly coated: several small sacculated stones co-exist.

Lastly, the period of infancy is one which presents peculiar difficulties to the operator. The structure of the organs interested is extremely soft and yielding, from which condition arise two sources of difficulty and danger. First, the staff is liable, if undue force be used, to be pushed through the walls of the urethra, and find its way below the bladder, between it and the rectum, where the mobility of the instrument, permitted by the laxness of the cellular connections, may lead the operator to believe that its point is in the bladder itself. If the error is not discovered in time, the operation fails to extract the stone, and mostly inflicts a fatal blow on the patient. And its not unfrequent occurrence proves that it is by no means a remotely possible danger. There is one great rule which is the only absolute safeguard against the performance of an operation on a staff which has not been passed into the bladder; and it is, to require clear audible or tactile proof of contact between the stone and the staff on which the patient is to be cut.

The other difficulty which arises from the soft and lax nature of the tissues, is the facility with which the membranous urethra may be separated from the prostate. This sometimes happens, when, after the deep incision, an attempt to introduce the index-finger into the urethra fails, and issues instead, in pushing onwards the prostate and neck of the bladder until separation takes place. The accident may occur in two ways. The operator may, through needless fear of having his deep incision too free, make a section of the urethra and prostate insufficient to admit the tip of his finger; and in attempting to dilate the opening with it, instead of incising afresh, the catastrophe occurs. Or, from this insufficient incision, as Dr. Murray Humphry points out,² the forefinger of the surgeon may, in failing to enter the urethra, make a kind of cavity between the bladder and rectum, and he may believe that he is in the first-named cavity. He may pass the forceps into this, and even feel the stone, thinly covered by the coats of the bladder, and attempt to make extraction. But, secondly, in the act of opening the membranous urethra, he may lose his hold of the spot with the nail of his left index-finger, and repeat the incision once, or even twice, before he gets his knife into the groove of the staff, and runs it on towards the bladder. The urethra meantime has shifted its position slightly, and three or four adjacent separate notches have been made into it. If only a small amount of force be employed in the subsequent attempt to pass the finger into the urethra, its separation from the prostate may also take place. This danger was pointed out by Sir William Fergusson in some valuable remarks on the operation in children.³ The remedy is, first to ascertain that the point of the staff is still in the bladder, and then to make a free incision of the prostate with a sharp knife—for these soft tissues are not easy to cut, and require both point and edge for a perfect section—so that the finger may be introduced into the cavity: this will generally be successful. A pre-

¹ See No. 2016, Hunterian Museum. Also a case was met with in the dissecting-room of Middlesex Hospital. A man aged 60 had three calculi in his bladder, two adherent fibres of submucous tissue being incorporated with the calcareous substance. They were carefully dissected by Mr. Nunn (see *Trans. Path. Soc.* vol. vi. p. 250). A smaller calculus, similarly adhering, was found at the Middlesex Hospital by Dr. Vander Byl, in the body of a woman aged 50 (*Trans. Path. Soc.* vol. ix. p. 196).

² See Lecture in the *Lancet*, April 23, 1864.

³ *Lancet*, July 2, 1864.

acquaintance with the danger, however, will be the best safeguard against its occurrence.

A difficulty which sometimes presents itself in the cases of children is prolapsus of the rectum during the operation. Young calculous patients are frequently subject to this affection from the straining which their complaint occasions, and when much protrusion occurs at the moment of operating, some embarrassment may be occasioned. All that is necessary is to press up the bowel so as to ensure its fair return, to put a small pad on the anus, and direct an assistant, placed on the patient's right side, to keep his finger firmly on the pad until the operation is completed.

Death, and its causes, following lateral lithotomy. 1. *The rate of mortality.*—It should be remembered at the outset that nothing can be more erroneous than the method of deducing a death-rate from an aggregate of cases which includes patients of all ages and of both sexes in unknown proportions. Nevertheless it is often the custom to do so, although it must be evident that no conclusion can be arrived at until the precise number of children have been stated, among whom the mortality is extremely small in comparison with the number of the aged adults among whom the mortality is very large. Hence it is absolutely essential, relative to any group of cases, to state the age of each one.

I shall again refer to the 1,827 hospital cases described at page 252, which may be regarded as an epitome of the practice of British hospital surgeons before lithotripsy became much adopted, and cases were separated for that purpose into categories of larger and smaller calculi, as adapted for the two operations respectively.

Mortality Rates at all Ages in 1,827 cases of Lateral Operation, in Metropolitan and Provincial Hospitals.

	Cases	Deaths	Cases
Norwich (Crosse)	669	91	about 1 in $7\frac{1}{3}$
Since that time	124	15	" 1 " $8\frac{1}{4}$
Oxford	110	14	" 1 " 8
Leicester	90	8	" 1 " 11
Leeds	29	4	" 1 " $7\frac{1}{4}$
Birmingham	102	10	" 1 " 10
Guy's Hospital	230	33	" 1 " 7
St. Thomas's Hospital	200	29	" 1 " 7
University College Hospital	90	12	" 1 " $7\frac{1}{2}$
Cambridge	183	13	" 1 " 14
Total	1,827	229	nearly 1 in 8

The same Cases, with the Mortality Rates at Different Ages.

During the Years	Cases	Deaths	Cases
1 to 5 inclusive	473	33	or about 1 in $14\frac{1}{3}$
6 " 11 "	377	16	" 1 " $23\frac{1}{2}$
12 " 16 "	178	19	" 1 " $9\frac{1}{2}$
17 " 20 "	76	11	" 1 " 7
21 " 29 "	86	11	" 1 " 8
30 " 38 "	75	7	" 1 " $10\frac{1}{2}$
39 " 48 "	100	17	" 1 " 6
49 " 58 "	191	40	" 1 " $4\frac{3}{4}$
59 " 70 "	233	63	" 1 " $3\frac{3}{4}$
71 " 81 "	38	12	" 1 " $3\frac{1}{6}$
Total	1,827	229	

The following modification of the above shows the mortality at the different epochs of life :—

Mortality Rates at Different Epochs of Life.

	Cases	Deaths	Cases
1 to 5, infancy and childhood, 473 cases, 33 deaths, about 1 in $14\frac{1}{3}$ cases	850	49	about 1 in $17\frac{1}{3}$
6 „ 11, boyhood, 377 cases, 16 deaths, about 1 in $23\frac{1}{3}$ cases			
12 „ 16, boyhood, with increasing development and setting-in of puberty	178	19	„ 1 „ $9\frac{1}{2}$
17 „ 29, adolescence and manhood	162	22	„ 1 „ $7\frac{1}{3}$
30 „ 48, adults	175	24	„ 1 „ $7\frac{1}{3}$
49 „ 70, advancing life	424	103	„ 1 „ $4\frac{1}{8}$
71 „ 81, advanced life	38	12	„ 1 „ $3\frac{1}{6}$
Total.	1,827	229	aver. nearly 1 in 8

2. *Causes of death after lithotomy in adults.*—The causes in children will be considered subsequently.

(a) *Causes due to error or mischance in the performance of the operation.*—The ‘deep incision’ may produce fatal bleeding, either at first, or occurring as ‘secondary hæmorrhage’ some days after. This rarely happens from reckless use of the knife, although such an event is possible; but is more commonly due to the physical necessity for making a free opening for a large stone: also from the irregular distribution and presence of a large artery in the line of the incision, an occurrence, however, which is usually to be controlled by the ligature.

Mechanical violence inflicted in the removal of the stone, especially when the opening is of insufficient size, is another cause. This is probably the true explanation of certain appearances revealed by autopsy, and formerly regarded as the results of infiltration produced by too great freedom of incision. Thus, after a large stone has been extracted with difficulty, the cellular connections of the neck and base of the bladder are found to be disorganised; sloughs of connective tissue are seen bathed in fluid seropurulent and urinous, and marks of peritonitis, especially severe in the pelvis, may be observed. Such are the signs formerly regarded as evidence of ‘urinary infiltration’ through too extended incisions. But there is good reason to believe that, in most cases, urinary extravasation is not the primary cause of the inflammation, but that inflammation produced by injury has been the occasion of any urinary extravasation, if such there be. In some of these cases, insufficient incision has furnished the occasion for inflicting violence in attempting to remove the stone. Undoubtedly sound as the rule is, to keep the internal incision strictly within the prostate in adult patients, sometimes the desire to limit it has in practice been carried to an extreme degree, and the no less serious evil of injuring the soft parts by violence has been substituted: viz. the evil of dragging the calculus through an opening of insufficient size. The student who is taught to fear beyond all things an approach of his knife to the peripheral limit of the prostate, in over-dread of cutting it, barely divides the prostate at all. Hence the fatal injury which results from violence inflicted by the forceps and by the stone upon the neck of the bladder, and by the powerful traction upon it, which injures, often irreparably, the delicate structures around.

Some of the most successful lithotomists have, in recording their experience, advocated sufficient incision as less dangerous than violent extraction. Thus Martineau of Norwich writes, in an account of his method which he presented to the Medical and Chirurgical Society in 1821: ‘Should the stone be large, or there be any difficulty in the extraction, rather than use much force, while the forceps have a firm hold of the stone, I give the handles to an assistant, . . . while the part forming the stricture is cut, which is easily done, as the broad part of the

blade becomes a director to the knife; and rather than lacerate, I have often repeated this enlargement of the inner wound two or three times.'¹ Cheselden himself had recorded a similar opinion. Describing his method of extracting the stone, he says, 'I first feel for the stone with the end of them' (the forceps), 'which having felt, I open the forceps, and slide one blade underneath it, and the other at the top; and if I apprehend the stone is not in the right place in the forceps, I shift it before I offer to extract, and then extract it very deliberately, that it may not slip suddenly out of the forceps, and that the parts of the wound may have time to stretch; . . . and if I find the stone very large, I again cut upon it, as it is held in the forceps.'² But, on the other hand, it is never to be forgotten that the neck of the bladder is susceptible of dilatation to a very considerable extent, if only it be gradually exerted. It yields, first, to the pressure of the finger as it passes through immediately after the knife; secondly, it dilates further in the act of sliding in the forceps upon the finger; and lastly, it gives way still more when the forceps is withdrawn, with the stone between its blades. Its susceptibility of becoming dilated is of the utmost value to the lithotomist; indeed, if it did not exist, and largely too, none but small stones could be withdrawn through any incision limited to the prostate only. But in order to take advantage of it, the dilatation must be made slowly and gently. If done hastily, harshly, and forcibly, under the influence possibly of the contemptible vanity of achieving a rapid operation in the eyes of bystanders, it is not dilatation which has been accomplished, but rupture. In this way inflammation of the cellular tissue, pelvic abscess, or phlebitis, may be easily set up.

An occasional cause of death connected with the operation is perforation of the bladder producing peritonitis.

I have myself verified this accident in two cases, and have little doubt that it is not a very infrequent cause, while it is certainly one which may be avoided without difficulty. Both cases occurred some time ago at the University College Hospital, and were publicly examined by me in the deadhouse there. I confess the circumstance was at that time new to me, and I think it deserves careful attention. Before the time of these accidents I had often observed the extreme tenuity and, in some cases, softness of the vesical coats in disease. Now nothing can be more likely to happen sometimes, unless we are on our guard as to this source of danger, than the pushing the point of a staff through the upper fundus of a contracted bladder, if the instrument be so long as it often is. I have since been frequently struck with the unnecessarily long curve which some staffs have, and have felt, when seeing such an one in use, how dangerous its point must be in a bladder affected in the manner described. I am strongly inclined to think that in those cases of rapidly fatal peritonitis which are sometimes met with after lithotomy, if the search were carefully made, a minute rupture at the upper and back part of the bladder would be sometimes found. It may be very small, lying between the rugæ of the organ, and easily escape observation, yet give issue to a small quantity of urine into the peritoneal cavity; for it is not very easy to explain otherwise some of these attacks which carry off a patient in thirty-six hours or so after operation. Extension of inflammation from the bladder to its peritoneal covering has been suggested, but I think the mechanical cause a more probable one. Let me say that injury to such bladders may as readily be inflicted by the forceps as by the staff, but I do not think the knife has anything to do with it. Clearly, in the two cases in question, the little openings were not so made: both the character of the orifice and its situation preclude such an explanation. Besides, I am quite sure that the danger of perforating the bladder with the point of the knife must be an extremely remote one, and impossible in fairly competent hands.

(b) *Causes of death which are not under the control of the operator, but are due to defective conditions of the patient's constitution.*—I have re-examined this part of my subject during the last few years, by the light of a larger personal experience. About three years ago I presented to the Royal Medical and Chirurgical Society, London,

¹ *Med.-Chir. Trans.* vol. ii. p. 411.

² *Cheselden's Anatomy* (5th ed. 1740), p. 231.

a *résumé* of 500 cases of operation for stone on *adult males only*, of which seventy-eight were operations by lithotomy.¹ All these were cases of large stone, or otherwise disqualified by some untoward circumstance for the performance of lithotripsy, and exhibited grave examples of the malady. Hence among them were twenty-nine deaths following the operation; a number almost equalling those occurring in all the other cases (422) of lithotripsy. Regarding the twenty-nine fatal cases of the first series, as well as the fatal adult cases of other operations, I think the following causes of death may be enumerated, and in the order of frequency of their occurrence :—

Organic disease of urinary organs, kidneys, ureters, and bladder.

Exhaustion of the vital power.

Peritonitis.

Septicæmia.

(a) *Organic diseases of urinary organs*.—Associated with the presence of vesical calculus of large size, a common condition is pyelitis, or pyelo-nephritis of one or both sides. If of long standing, the affected ureter and pelvis are not merely inflamed, but become dilated, sometimes very largely so; they may even form receptacles for offensive urine. Consequent changes in the renal structure take place; a gradual thinning and disappearance of it, as if from pressure, while small purulent deposits in it occur in the latest stage. The disease, however, originated in the bladder, which might at first be thickened or distended, or sacculated, a condition varying greatly in degree and extent; but always an extremely grave circumstance in connection with operation of any kind, when the sac or sacs are of considerable size. Such changes existing, they are liable to be intensified both by the local effect of an operation on the bladder, and by the constitutional, or febrile, state which follows it. Acute inflammation of the bladder also sometimes results from lithotomy, and appears to aggravate the renal state, although it may not spread upwards by continuity of structure, and death rapidly follows.

Again, the kidneys may be already damaged, although in a minor degree, by pre-existing calculus formation, or one of them may be still the seat of calculus; and thus danger may arise in event of operation. Bright's disease is a very grave complication; while the long-continued presence of saccharine diabetes is undoubtedly a serious element of risk. Death sometimes occurs in any of these cases from uræmic poisoning, through insufficient eliminating power of the kidney; or by acute inflammation and suppuration destroying their structure.

(b) Next in order may be ranked *exhaustion of the vital powers*. In other words, a patient free from any pronounced organic disease lingers a longer or shorter period after the operation, having perhaps afforded good hope of recovery during the first few days, after which he fails to improve, becomes gradually weaker, and dies without acute disease in any organ. Such exhaustion may be manifested slowly or rapidly, and either with or without the occurrence of secondary hæmorrhage, which may often occur insidiously, and before it can be checked; while primary hæmorrhage, on the other hand, is to be regarded as controllable by the surgeon. Nevertheless, the patient may have unavoidably lost more blood than usual, which at advanced years, and perhaps with impaired digestion also, he is unable to restore. There are, of course, some old and worn-out cases in which the slender chance of recovery by means of operation is embraced by the patient only in his last extremity; when, with powers past recruiting, he is brought to the operating-table. But if hæmorrhage be unavoidably severe, or be not checked by every means at hand, we risk a fatal encounter with exhaustion, and indirectly not a few deaths are thus met with. It follows then, that the surgeon should, during the operation, regard his patient's blood as valuable in the highest degree, and should rest assured that every ounce of blood lost in lithotomy is, *pro tanto*, a positive injury to an elderly patient.

¹ *Trans. Royal Med.-Chir. Soc.* 1878, vol. lxi. p. 159.

(c) *Peritonitis*, as already seen, may arise by perforation of the bladder by the staff, and also as a secondary result of violence, or of sloughing and suppuration at the base of the bladder. But it appears also to arise independently of these local conditions, possibly sometimes by extension from an inflamed bladder, and sometimes as one of the manifestations of blood-poisoning.

(d) *Septicæmia*. The occurrence of septic poisoning from any cause is not very common in connection with lithotomy. Among the twenty-nine deaths which occurred in my own cases, only one could be reckoned under this head. In that case, the presence of pyæmia was rapidly manifested by articular swellings, with death on the seventh day. This fact is worthy of note, in connection with the keen interest now felt in researches as to the nature and origin of septicæmia; as an illustration of the small liability to receive infection which some wounds exhibit. The wound in lateral lithotomy can scarcely be guarded by any device from access of common air, nor from much that is manifestly impure, and no attempt has been made in these cases to prevent such access; yet with many instances of prolonged contaminated exposure, often amounting to some weeks, only one example occurred. On the contrary, the lithotomy wound may be regarded as an example of the 'open-air' treatment; no dressing or covering of any kind has ever been applied in my cases; and as much fresh air as possible has been admitted.

(e) *Tetanus*. Two or three cases are on record of death by tetanus following the operation of lithotomy. Beyond the bare mention of this fact, no further remark appears to be necessary respecting this extremely rare event as a consequence of the operation.

The causes of death in children.—The causes of death in children are widely different from those which are met with in adults.

It is easy to arrive at this inference if we observe the circumstances which render lateral lithotomy so much less fatal in the child than in the adult, a fact notorious to the youngest student: the first is the fact that the sexual organs are not yet endowed with that special sensibility, the development of which constitutes the state of puberty; a sensibility which, depending on intimate connection between those organs and the cerebro-spinal system, associates them by the closest ties with all the other vital functions in the economy. In the child there is, in fact, no sexual apparatus; that is to say, its condition is at present rudimentary, and the young patient is exempt from the dangers which may threaten the developed adult. The second is this, that the processes of growth and repair are more vigorous during childhood than during any other term of life; and injuries are more easily surmounted than when those processes are less active.

The liability to death after lithotomy in childhood varies at different epochs of that period. The table at page 280 containing 850 cases of children, shows that from the first to the fifth year inclusive the deaths are about one in fourteen cases; they then decrease, so that between six and ten years inclusive they are only one in twenty-three or twenty-four cases. Between eleven and sixteen the mortality gradually rises to one in nine and a half cases, and from the sixteenth to the twentieth year to one in seven cases. During the first three or four years of life lithotomy is less successful than subsequently. The first dentition, and the excitable nervous system of infancy at that period neutralise other advantages to some extent. But as these two sources of trouble disappear, we find the boy of six to ten years almost free from risk, the mortality being one in twenty-three or twenty-four cases, or little over four per cent. The development of puberty shows its influence between twelve and sixteen, and during the first onset of its influence on the system between sixteen and twenty, before the man is fully developed, lithotomy is slightly more hazardous than at any period during the subsequent twenty years.

The most frequent cause of death in children is *peritonitis*. The bladder in children is an abdominal organ rather than a pelvic one, and has more intimate relations with the peritonæum than the bladder of the adult possesses. On examining

its structure, also, it is easily seen that the peritoneum is more entitled to its anatomical distinction of constituting one of the vesical coats in the child than in the adult. Hence, violence in extraction tells much more readily and directly on the peritoneum in the former than in the latter. The prostate has not to be taken into account by the operator, who must incise whatever be necessary to permit of a fair opening into the bladder. I have dissected many prostates in children; the size of one at seven years, the most favourable age for lithotomy, weighs only about thirty grains; while between eighteen and twenty years it weighs two hundred and fifty grains, or nearly nine times as much. And yet no infiltration of urine takes place; lax, delicate, and yielding as are the cellular connections necessarily exposed in these subjects.

The next cause of death is *exhaustion*. Young children bear the loss of blood badly, and when it is considerable—an occurrence, which, however, is rare—the patient sometimes sinks from subsequent exhaustion. The condition of calculous children also, if the stone has long existed, is occasionally low in the extreme, and they gradually sink without any apparent effort to rally, no active attack having declared itself. Besides these two principal causes of death, there are occasional examples of fatal result from shock after very prolonged or severe operation; from disease of the kidneys and bladder, from phlebitis and intrapelvic abscess, which demand no special remark here.

Choice of operation.—A few remarks will suffice in relation to the choice of operation, when it is evident that lithotripsy is not to be employed for any particular case. And it may perhaps be said, somewhat forestalling the discussion of the subject in the succeeding article, that lithotripsy in its most modern form may be held as sufficient and preferable for a very large proportion of all vesical calculi in adults; it may perhaps be said, for nine-tenths of all the cases, perhaps even for a larger number. It follows that the cutting operation is required then only for a few exceptional cases, and the circumstances which constitute a case exceptional must be considered at the outset.

1. *Extreme size associated with density of structure.*—It is manifestly impossible to lay down any precise limits as to size; but there is no doubt that, among stones of equal size, oxalate of lime will furnish the greatest difficulty if any crushing or fragmentation is to be performed; with uric acid, the difficulty will be less; and with phosphatic products little difficulty may exist. Hence, without regard to any statements respecting weight, it is quite clear that cutting operations are now required only for large stones. For these cases, at any rate, which unquestionably form the chief exceptions to the rule of lithotripsy, no form of lithotomy is applicable which will not provide for the removal of a large quantity of calculous matter without serious difficulty.

2. When confirmed organic stricture of the urethra is present, and a somewhat large stone occupies the bladder, lithotomy in some form is also indicated. As will be hereafter seen, in the majority of instances in which these two morbid conditions coexist, lithotripsy offers the best mode of proceeding for the patient.

It has been generally held by all surgeons who have practised both the lateral and the median operations, that the latter is more suitable for calculi of small or medium size, and the former for the largest examples. But it is to be remembered that, the presence of stricture only excepted, all calculi short of the largest are removable by lithotripsy. There is no necessity therefore now for a cutting operation adapted only to small stones. But abroad, at least, a median operation is employed which gives space for the removal of large calculi, and which is said there to be especially convenient for the employment of fragmentation of the calculus before removing it: I refer to the medio-bilateral operation, which in its first step is identical with our ordinary median operation; the second step consisting of a horizontal bilateral incision through the prostate by means of a lithotome. I have myself performed this operation several times, between the years 1860-70, and relinquished it in favour of the

lateral, which, on the whole, I have rather preferred. I do not think, however, that there is ground for any strong preference for either, if the breaking up of the stone is to be a preliminary to extraction. If a large stone is to be removed entire, I do not hesitate to prefer the lateral.

The High operation is not to be lost sight of: I have employed it twice, and would remark that the condition of the subject must be taken into consideration, rejecting one who is unduly stout as unfitted for it. Where the bladder is fairly distensible it may be undertaken, especially for large calculi in children, otherwise I should not advocate its adoption.

In connection with these few remarks the reader may be referred to those already made on the subject of large calculi on page 276, and also to the subject of applying lithotrity to large calculi, hereafter to be discussed.

HENRY THOMPSON.

LITHOTRITY.

BY the term LITHOTRITY, since custom has popularised it, all those processes may be denoted by which the stone is broken up, crushed, and powdered in the bladder, and by which the débris are removed through the natural canal of the urethra without the use of the knife.

There is reason to believe that calculous matter has been occasionally removed by lithotritry at various early dates, but no attempt seems to have been made to apply the principle, systematically, until A.D. 1813, when Gruithuisen, a surgeon in Bavaria, proposed a plan for seizing and reducing to powder, by drilling, a stone in the bladder. Subsequently, in 1819, Elderton, a Scotch surgeon, published a somewhat similar proposal. Meantime, in 1817, Civiale, of Paris, designed his earliest instruments; and was closely followed by Leroy d'Etiolles and Amussat, in the production of other instruments for the same purpose. The first successful operations, however, were undertaken in 1824, by Civiale, who performed them before a committee of the French Academy. Improvements in the instruments and also in the method were made by Weiss, Heurteloup, L'Estrange, Costello, Brodie, Charrière, and others, as well as by Civiale himself, whose experience was in his time greater than that of any other operator. It is his method which, during several years, was followed by myself. My own experience, however, becoming very large, led me to modify the lithotrite, and the method also to a certain extent with it; and thus the operation became more rapid and safe than any previously practised. Much more recently has appeared the proposal of Professor Bigelow to crush more completely, and to remove all débris by larger evacuating catheters at one sitting—a proceeding which is calculated in competent hands to render lithotritry more largely applicable, and more successful, than heretofore. Previously, although many small calculi were removed by a single application of the lithotrite, all above the size were reduced by several sittings with intervals of three or four days between each, and the débris was partly removed by instrument, and partly left to the patient's natural power to expel. Now, however, it is the aim of the surgeon, by means of prolonged crushing and artificial evacuation, to remove an entire stone, although large, at a single sitting. This change will be more fully considered hereafter.

Treatment preliminary to the operation of lithotritry.—Among the calculous patients admitted into hospitals in the metropolis, most show signs of general deterioration of the health, the result of pain, loss of rest, and other depressing influences of their malady. Something, therefore, should be done by rest and soothing local means to improve their condition before deciding on, or proceeding to, the operation; for it is unwise to operate on a bladder which is the subject of unchecked chronic inflammation, a condition not infrequent, although often absent, in calculous cases. When it does exist, incautious interference may set up acute cystitis and lead to mischief in the kidneys, and a fatal issue.

We should also examine the urethra with a full-sized soft olivary bougie, and if the passage is not quite ample, it should be sufficiently dilated; or the external meatus may be divided, so that the lithotrite and a large evacuating catheter may pass easily.

Most commonly, if the patient is in fair condition, the removal of his stone, especially if it can be accomplished at a single sitting, will be the best means of diminishing local inflammation, and of inaugurating a new and tranquil state of the bladder, in which it will rapidly regain its healthy tone.

Nevertheless, it is desirable to have favourable conditions present if possible; they

are not essential to success, which happily is often achieved in their absence. Such conditions are —

1. A capacious and not very tender urethra.
2. A bladder capable of retaining three or four ounces of urine.
3. Absence of the ordinary signs of renal disease ; and fair general health.

FIG. 69. — Lithotrite with cylindrical handle.



A, wheel-shaped end of sliding shaft, held in the operator's right hand, which directs the movements of the male blade E ; B, the screw.

D, the button which throws the screw into gear or releases it, as desired ; C, the cylindrical handle attached by outer shaft to the female blade F.

What is the precise object of lithotrity? is a question which must be proposed and definitely answered at the outset of any consideration of this subject. The object of lithotrity has been until late years, as already stated, to be the reduction of the stone to the form of débris, sufficiently small to be expelled chiefly by the patient's natural efforts during the act of micturition.

Of late, the artificial removal of débris has also been employed, and increasingly so; and the object of lithotrity may now be defined as, first, to reduce a stone to fragments sufficiently small to pass through an evacuating catheter which can be introduced into the bladder without injury to the passages; and, secondly, so to remove the fragments without unnecessary delay.

In the performance of the necessary manipulations to effect this object, it is obvious that any evils arising therefrom are produced by mechanical injury to the bladder or urethra; the direct agents in producing it being instrumental interference, or the presence of sharp or angular fragments.

Therefore it must be our aim, first, to reduce the stone to fragments in the most efficient manner without injury to the passages; secondly, to remove the fragments at once whenever possible; and, finally, to accomplish these objects by the smallest amount of instrumental interference.

Instruments for crushing stone: lithotrites.—It should be remarked at the outset that every point relating to the form, weight, size, and construction of a modern lithotrite has been arrived at after much experience and careful attention to the necessities of hundreds of cases, and after the occurrence of numerous contingencies, not anticipated at first, but now provided for. All lithotrites possess the following principal parts: the blades, the shaft, the sliding-rod, and the handle (fig. 69). The blades are two in number; one distal (from the handle), immovable, continuous with the shaft, called 'the female blade;' the other proximal, movable, continuous with the sliding-rod, and called 'the male blade.' The shaft is perfectly straight, and forms the longest portion of the instrument, corresponding to the average length of the urethra and two or three inches over. The sliding-rod is received into a longitudinal channel, occupying the entire length of the shaft; it bears at one end the male blade, at the other it is acted upon by the mechanical power employed; and on its upper surface, near to this end, is marked a scale showing to what extent the blades are separated, when hidden in the bladder from the surgeon's eye. The handle not only serves the purpose which its name implies, but contains, or has affixed to it, the mechanical power which is destined to move the male blade.

Up to a recent period, lithotrites were regarded as occupying two distinct classes, arising out of the nature of the work required to be accomplished by them.

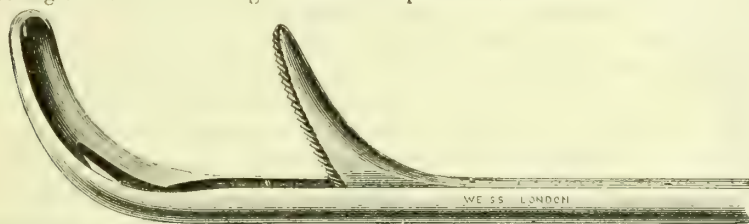
Class I. Lithotrites with the female blade open or fenestrated; for breaking the stone into large fragments; which they, the instruments, are incapable of removing from the bladder.

Class II. Lithotrites with only a small opening in the female blade; for reducing

the stone into small fragments or *débris*; and which these instruments are capable of removing from the bladder when necessary.

But a good modern aspirator being unquestionably superior for the purpose of removing *débris* to the flat-bladed lithotrite, the latter, although still required, is less used than formerly. A safe and efficient lithotrite for reducing the stone to a condition in which it is easily removable by aspirator and evacuating catheter is what is now demanded. And as it must be fitted to work in the bladder during some minutes before being withdrawn, it is essential that it should be so constructed that the blades cannot be choked with *débris*, and so rendered unable to close; a condition which may occur with the ordinary flat-bladed lithotrite, if worked for some time without withdrawing it to be cleared. Hence I have adopted some

FIG. 70.—Represents the Male and Female Blades and the Opening which is filled by the projection of the lower part of the former when the Lithotrite is closed. The opening should be made larger than here represented,



powerful but not large lithotrites, on a principle of construction which is intermediate between these two classes, and avoiding the objectionable points of each; the female blade fenestrated, the male blade partly wedge-shaped (see fig. 70) but not closely fitting into the former. The old fenestrated lithotrites, if not too clumsy, may also be used, since they are powerful instruments. But they should not be employed if the edges of the blades are sharp and fit closely to each other, as the mucous membrane may be readily included between them (see fig. 71). This source of

FIG. 71.—Fenestrated Female Blade, with large teeth: a powerful Lithotrite.

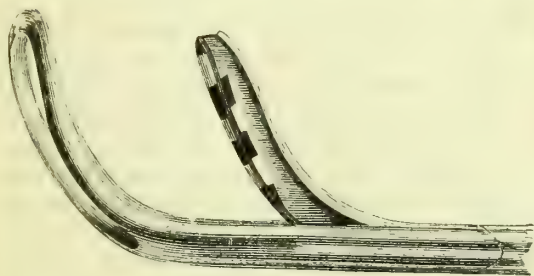
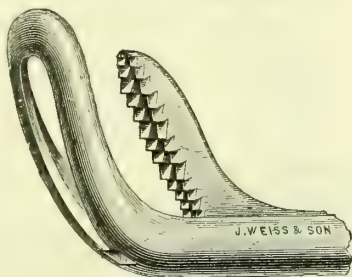


FIG. 72.—A large and powerful Fenestrated Lithotrite.



danger does not exist in the lithotrites previously mentioned, which have moreover the cylindrical handle, almost universally recognised now as the best to employ. There is, however, no better instrument than the fenestrated lithotrite, if the edges are bevelled and the handle above alluded to is provided. (Two forms are appended.)

The flat-bladed crushing instrument is a very safe and efficient lithotrite where it is applicable—that is, for small stones—and is possessed of considerable power and strength, although not equal in this latter respect to those of the first class. The margins of the jaws are not sharp, but well bevelled; moreover, it is scarcely possible, from its construction, to seize or nip a piece of mucous membrane between the edges of the male and female blades, a considerable interval existing between them (the edges only) when the blades are closed. There should also be a fair opening in the angle of the female blade through which any impacting *débris* may be driven by the male blade, if any sign of blocking shows itself when operating. This instrument will also perform the office of the old ‘scoop,’ when required, as

well as any other instrument made. The blades being flat, much *débris* may be contained between them without unduly enlarging the calibre: their capacity in this respect is remarkable.

Thus much for that portion of the lithotrite which transmits the applied force, by direct contact, to the stone itself; we must also consider that portion of the instrument by which the force is accumulated and applied. The conditions necessary to the construction of this portion are—first, power in abundance; second, power which can be quickly applied, and in small or large quantity at the will of the operator; third, power which can be disengaged and re-applied with ease and rapidity; lastly, all these conditions to be fulfilled, and to be made effective in small compass and without the necessity for harsh movements capable of communicating injurious concussion to the bladder or urethra.

The screw is a form of mechanical power which admits of great pressure being gradually, evenly, and continuously applied. But the production of rapid impulse and percussion are also with practice both compatible with the action of the screw. One great drawback in the original screw instruments was the loss of time expended by unscrewing, in order to open the jaws of the lithotrite which have been closed in the act of crushing. Numerous devices have been adopted in order to meet this difficulty, and enable the operator to change, by the simplest movement possible, the screw action into a sliding movement, and vice versâ. This was some time since accomplished in the most perfect manner by Messrs. Weiss, and modifications of various kinds have been produced by other makers, according to the suggestions, or to meet the wishes, of various surgeons. The handle of the lithotrite was also then made cylindrical in accordance with my own design; and this form enables the operator to employ the lithotrite with greater ease and nicety than before. It is the power of employing this instrument with the lightest possible hold by the finger and thumb, in any direction, which imparts its peculiar facility for the detection of small stones and fragments. This will be especially shown when that subject comes in due course for consideration; but I may say here that it is perfectly easy for a practised hand to elicit an audible note from a fragment of calculus in the bladder, the size of which fragment is no larger than a split pea. The same cylindrical handle, moreover, enables the operator to hold the instrument with a firm and steady grasp when this is required.

Instruments for removing fragments from the bladder. Aspirators.—Various

FIG. 73.—Sir Philip Crampton's Aspirator.

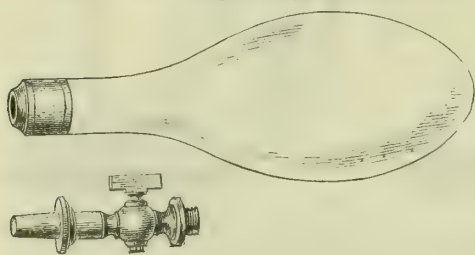
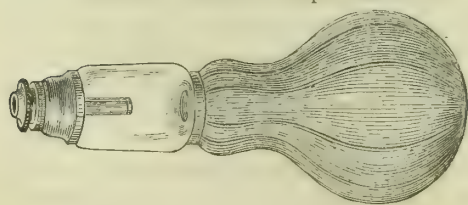


FIG. 74.—Clover's Aspirator.



attempts were made during the early history of lithotritry to remove *débris* artificially, as by double-current catheters, large evacuators, with a powerful syringe, &c.; none of them producing results satisfactory to the operator. The idea of removing *débris* by means of 'suction' or 'aspiration' appears to have been first realised by Sir P. Crampton of Dublin, whose apparatus consisted of a glass receiver, like a large soda-water bottle, from which, by means of an exhausting syringe, he removed the air, and then applied it to a large silver evacuating catheter previously introduced into the bladder.¹ Into this cavity some twelve or fourteen ounces of water had been injected, so that on turning a tap attached to the receiver a powerful rush

into it of water and *débris* took place. It was dangerously rough in action, requir-

¹ *Dublin Quarterly Journal*, Feb. 1846, pp. 22 and 43. Drawn and described in the 'Enlarged Prostate' (by Sir H. Thompson: London, 1857), pp. 297-9.

ing to be so repeatedly charged and applied, as not to be worth in product the manipulation required. Soon afterwards Mr. Clover designed an india-rubber aspirator with a glass cylinder, trapped to prevent reflux of fragments, which answered its purpose exceedingly well. The evacuating catheters were silver, Nos. 12 and 13 in size (fig. 74). This is still a useful instrument, especially if made rather stronger than formerly, and it may have a cylindrical receiver at the bottom of it if desired. Professor Bigelow used as his first aspirator a strong large india-rubber bottle, from the top of which a long tube was attached to the catheter in the bladder, but he has modified this several times. A later form which he has designed is less simple in construction than any I should employ, although acting well with artificial fragments of uniform size in rigid vessels. The conditions under which we perform lithotripsy in the human bladder, varying as it does every instant in size, and varying also in different individuals in regard to form, contractility, suppleness, &c., render experimental trials in rigid receptacles almost valueless, being quite without analogy to the conditions of the organ in the living subject. Experience in the latter must guide us as to the best instruments of any kind to be used there. In designing a new aspirator at the outset for the one-sitting operation, I came to the conclusion that the following points are essential in the construction of an efficient instrument.

1. It should be light and small, so as to be easily grasped and governed by one hand.

2. It should have an opening *at the top*, by which it can be filled with water, to which all air accidentally admitted, if any, will arise, and by which it can escape.

3. Its *lower part* should be connected with the evacuating catheter by the shortest route to the bladder, and in such a manner that the aspirator can be detached with ease, and without loss of any contained water in so doing.

4. There should be a trap into which all fragments must fall, and by which they are securely retained.

These conditions are all present in the aspirator shown at fig. 75. Recently a valuable alteration has been made, as shown at fig. 76, which is identical with fig. 75 in every particular, except that the cylindrical receiver, which is in fig. 75 directly under the bottle, and may be slightly influenced by currents, is removed to the front of it, and is perhaps less disturbed by the current which passes over the mouth of the receiver. My recent experience of this form leads me to prefer it to any other. In neither fig. 75 nor fig. 76 is any stand required, and the connection with the bladder is the shortest and simplest possible. The connection of the aspirator with the bladder is also cut off in both instruments by the taps *r*.

In describing the operation of lithotripsy and giving directions as to the manner of performing it, I may briefly refer to a fact named at the outset, viz. that whereas up to a recent period all calculi above a given moderate size were removed at several separate sittings, the most recent method is to remove even a large calculus at one sitting only. The attempt to do this had been made by several operators, even at an early period. Heurteloup advocated it very strongly in 1837. Fergusson endeavoured

FIG. 75.—Author's original Aspirator.

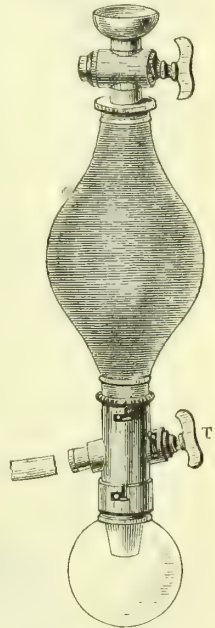
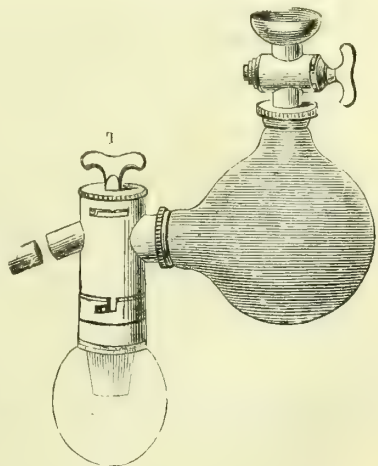


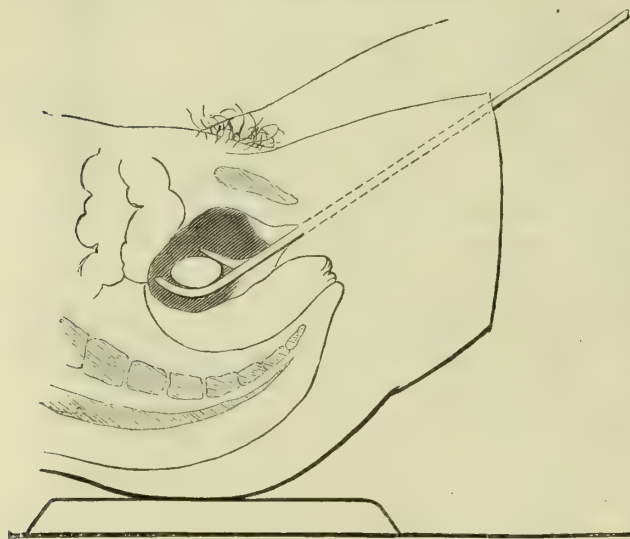
FIG. 76.—Recent change in the situation of the Trap.



to accomplish it by withdrawing fragments, under ether, by the urethra; and under exceptional circumstances I had myself, notably in cases of severe cystitis, removed large quantities of calculous matter, by means of Clover's aspirator, with marked success, before 1870. This system I strongly enjoined both here and abroad, where especially the waiting and soothing treatment has been pursued in these circumstances, and application of the lithotrite postponed, in obedience to the powerful traditions of Civiale's teaching.

In 1878 an important change was proposed, as is well known, by Professor Bigelow. He advised that the stone, however large, and without respect to the presence of cystitis or other considerations, should be invariably removed at one sitting, by means of more powerful lithotrites, larger evacuating catheters, and a stronger india-rubber bottle than had before been used. The condition necessary and preliminary to this proposal had been the adoption of a doctrine taught by Otis of New York, that the ordinary male urethra might be treated as capable of fairly admitting instruments of 16 or 18 gauge English, or Nos. 27, 30 French, instead of Nos. 12, 14 English, 22, 25 French, which had been generally regarded in the

FIG. 77.—The ordinary Position.



two countries as about the limits of safety in dealing with an ordinary healthy urethra. Once satisfied that the canal would safely admit the larger instruments under the influence of ether, there was no longer reason why a large and hard stone should not be removed, so far as the mechanical procedure is concerned, at one operation. Bigelow believed that it would be safer to empty the bladder, even at the cost of manipulations much more prolonged and severe than had been deemed practicable, than to operate by several sittings with fragments left in the

bladder during the intervals of operating. This method has now been employed by several surgeons both here and elsewhere, and I have used it almost solely now about three years. The remarkable success which it has achieved, and the details of which will be given in their place, render it no longer a question for discussion whether or no the old practice of many sittings or the new 'lithotrity at one sitting' should be performed. The advantages are so clearly in favour of the latter operation, that it only will be described here. At the same time, any instructions relating to the new procedure must of necessity embrace all manipulations belonging to the old; so that all exceptional instances in which more than one sitting may be necessary—and such it is admitted may present themselves, especially to operators who have not had large experience—will be provided for.

The position in which a patient is to be placed, upon whom lithotrity is to be performed, is a matter of importance, and should be satisfactorily arranged before ether is administered. He should lie easily on his back in bed (or on a couch close by, if preferred); if on the former, upon a firm mattress, so that the pelvis does not sink, a position fatal to good practice; and he should be brought with his right side close to the edge of the bed. The pelvis is to be raised above the level of the shoulders, which must remain on the same plane as the rest of the trunk, the head only being supported by a pillow. A firm cushion, about three or four inches thick,

should be placed under the pelvis; an excellent substitute, to be found in any bedroom, is a common pillow rolled up tightly in a towel, which is then fastened by pins.

The thighs are to be separated a little, so that there is an interval of a foot or more between the knees, and each knee may be supported by an assistant if necessary, leaving the space between the legs clear for the operator.

The condition thus described constitutes that which is necessary for all ordinary cases; and when the patient is so placed, the stone generally lies a little behind the neck of the bladder, and may be easily found and acted on by the lithotrite, provided the bladder and prostate are normal.

In a few exceptional cases, where the prostate is very large, it is sometimes advisable to raise the pelvis another inch or two; but this is not often necessary.

In any case in which it is decided to perform lithotrity for a child, the pelvis should also be a little elevated.

The object of determining the position in lithotrity is, to prevent the stone from lying close to the neck of the bladder, which it almost certainly does if the pelvis sinks a little below the horizontal line of the body. The centre of the cavity and space beneath it form the area of operation. The neck, which is sensitive, easily injured, and ready to take on inflammatory action, is to be kept free from all unnecessary mechanical irritation—an important principle, not to be lost sight of in the conduct of lithotrity. The elevated position of the pelvis also enables the operator to reverse the lithotrite with facility; since, in order to do so, it is almost always necessary to depress the handle.

It is presumed that, in view of the operation, an olivary bougie has been passed in order to ascertain that the urethra is of fair size. As soon as ether has been administered, the operator should pass a conical metal sound—say No. 15 or 16, English scale—by which he learns whether he may subsequently use an evacuator of the same or of larger size if necessary. Usually one of these passes easily enough, and the operation proceeds at once. The question of preliminary injection first presents itself. Formerly it was held by all operators that, if the bladder did not naturally and readily hold four or five ounces of urine, the area in which to use a lithotrite would be dangerously small. Hence, an injection was made, or attempted to be made, of that quantity of warm water, and no attempt at crushing followed unless this often difficult preliminary was accomplished. I soon found that the practice was not only useless but injurious, disturbing the bladder, occupying time, increasing manipulation; and I have consequently not employed a preliminary injection for now nearly twenty years. Nor should the patient be desired to retain his urine before the hour fixed for operating, for the very attempt to do so often defeats the object; or nervous anxiety compels him to pass water immediately before or at the surgeon's arrival.

Perhaps three or four ounces may as a rule be always present with advantage, especially for young operators. Nevertheless, I am satisfied that, with instruments constructed on the principles laid down, no mischief can be done by proper manipulation in the bladder which is empty or nearly so; and I as frequently operate in that condition as not. On the other hand, a large quantity—say any above eight ounces—makes the area of operation too large, in which condition a small stone or a fragment may elude our search.

If the patient cannot retain his water more twenty or thirty minutes, he may require some little preparation by way of rest, &c.—a rare necessity; for if an attempt is made to compel the bladder to hold more than it tolerates comfortably, uncontrollable contractions are produced, pain is occasioned, and the organ is in an unfavourable condition for lithotrity. It is often the case that the only method of subduing irritation is to crush the stone; but experience only can determine the cases in which we should 'prepare' the patient, and those in which we should operate forthwith. With the powerful appliances of modern lithotrity, the latter alternative is, I believe, far more commonly presented than the former.

That condition of the bladder most favourable to lithotrity is one of healthy tonicity—a condition in which the organ contracts upon its contents sufficiently to

form a reservoir of tolerably regular form. An abnormal irritability, or disposition to contract, is objectionable on the one hand ; a flabby, unexcitable state of the coats is unfavourable, although in a less degree, on the other. It is so, because the stone is apt to be partially enveloped, it may be hidden, in loose folds of the bladder ; because the viscus, in place of forming, by its inherent tonicity, a somewhat ovoid figure, is influenced rather by the pressure of surrounding viscera, and may take any irregular form which they determine. Desirable as it may be to practise to some limited extent on the dead subject, it should be remembered that the condition of the dead bladder is very different from that which exists in the healthy living organ. In the dead body the stone does not lie at the neck of the bladder, but falls anywhere in the flaccid viscus, which position and the pressure of adjacent viscera render the lowest. By depressing the jaws of the lithotrite, the stone of course rolls into it. But this result is by no means a matter of course in the living. When tonicity is active, there is often a constant tendency in the muscles of the bladder to roll a large stone towards the neck, a fact of importance ; and the result of this action, though much modified by the position of the body, is by no means altogether counteracted by it.

The next step is to pass the lithotrite. The mode of introducing this instrument differs from that by which a catheter is passed, and it is important that the difference should be explained and observed. The difficulty frequently encountered in introducing the lithotrite is generally due to ignorance or neglect of the distinction existing between the two operations.

In catheterism, a smooth continuous curve or sweep is made from the external meatus into the bladder. Throughout the entire movement, the instrument describes a series of continuous curves ; the shaft of a silver catheter, at first horizontal (supposing the patient to be recumbent), is gradually moved upwards to the perpendicular and downwards to the horizontal again, in a direction precisely opposite to the first position.

In passing a lithotrite, the continuous sweep is not the best way of carrying it into the bladder : the terminal angular blades are thus brought into contact with the upper part of the urethra before the pubic arch is passed. On the contrary, the shaft of the lithotrite must be maintained in one position for a considerable part of its course, as will appear in describing the movement in detail.

The operator places himself on the right side of the patient, and stands with his back turned partly towards the head of the couch, his left side being to the patient's right. Having well oiled the lithotrite, he holds it lightly with his right hand, in a horizontal position, the blades pointing downwards, and raises the penis with his left ; and as he introduces the blades into the urethra, the left draws the penis gently over the angular end of the instrument, which descends in this manner down to the bulbous portion of the urethra, the shaft rising gradually towards the perpendicular. Having arrived there, it is not now to be depressed as in catheterism, since this movement raises the point of the blades against the roof of the urethra in front of the deep fascia above the narrow orifice of the membranous portion, while the large capacity of the bulbous urethra favours the malposition described, and, if force is used to overcome the difficulty, laceration will probably take place. This, indeed, is the accident which, more commonly than any other, happens in the hands of beginners, or with those who are not aware of the proper course to be pursued. In order to pass the blades easily and safely through the narrow membranous portion, it is necessary to maintain the lithotrite a few seconds at or near the perpendicular, permitting it to progress slowly in that position. This proceeding is accomplished by permitting a part of the weight of the instrument to act as the propelling power, while the penis is drawn upwards a little, in the same, that is the vertical, direction. In this position, the blades slide through the bulbous portion, enter and traverse the membranous portion, and arrive at the prostate. Then, and not before, the operator gradually depresses the instrument towards the patient's thighs ; the blades rise up through the prostatic portion into the bladder—a movement which is rendered more easy if a very slight lateral rotary motion is given to the instrument at this part of its progress. In ordinary, that is, normal, conditions the shaft of the lithotrite at the entry

into the bladder forms an oblique line and an angle of about twenty to thirty degrees with the horizon; and this it continues, as it slides easily and freely down upon the trigone to the posterior wall of the viscus. It will be obvious that the urethra now entirely loses its curve, being occupied throughout by the straight shaft of the lithotrite. The jaws being now closed and lying at the bottom of the cavity, or nearly so, the finding and seizing of the stone has to be achieved—a simple matter, provided only that certain principles are followed. A few preliminary remarks on the best method of holding the lithotrite are necessary, for the surgeon should be quite familiar with the best position and action for his hands upon it, before he operates in the living bladder, so that he may instinctively hold and manage the instrument according to the rules laid down, and has not to recall them to his memory at that moment. Without doubt, the best method with the existing lithotrites has been ascertained by practice and observation; and even supposing this were not the case, it would be advantageous to the operator to practise one method as the rule, and so acquire a facility in the use of the lithotrite, which practice by a uniform method alone can impart.

First, when the blades have arrived in the cavity of the bladder, the left hand being above the instrument, the cylindrical handle is at first lightly held between the thumb and three fingers, the little finger being free, so that a slight rotary movement of the instrument can easily be made on its axis, when necessary. The wheel-shaped end of the sliding rod, which terminates in the male blade, is then held between the thumb, index, and second fingers of the right hand (see fig. 78), so that it can be drawn out and pressed in at pleasure; corresponding to which movements, of course, the blades at the other extremity are opened and closed.

If a stone or a fragment be seized, the fingers are to remain on the wheel with slight pressure to keep the stone between the blades, and the thumb is to be extended to draw upwards the button, which act changes the sliding into the screwing action. If the stone or fragment is small, the fingers of the left hand remain in their place; if it is large, the cylindrical handle is grasped in the palm of the left hand, and perfect immobility is ensured (see fig. 79). A turn of the wheel now screws home the male blade, and crushes what has been caught.

In order to reverse the blades in searching for fragments, it is only necessary first to depress the cylindrical handle and then to rotate it between the thumb and fingers of the left hand, the wheel to be moved, if necessary, by the right hand. Indeed, every change in position of the blades is attained in this instrument by rotation with the left hand, while, at the same instant, the right hand is opening and closing the blades in search.

Next, the lithotrite being in position, how is the stone to be sought and seized?

FIG. 78.—Mode of employing the Lithotrite with Cylindrical Handle in searching. The left hand holds the cylinder lightly, while the right opens and closes.

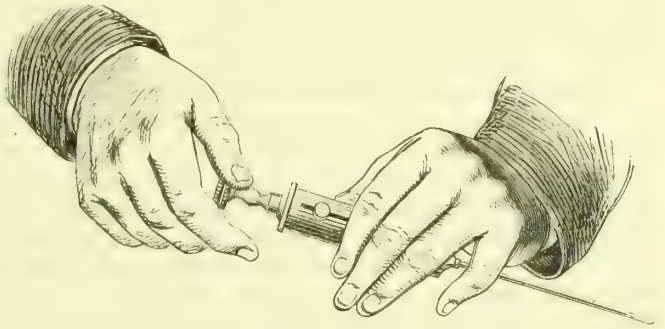
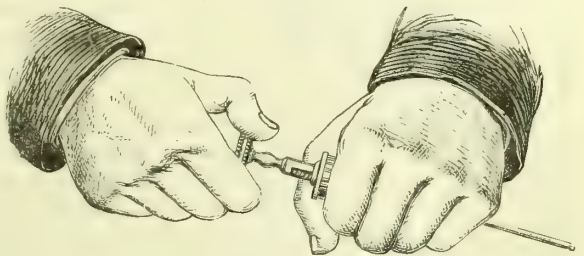


FIG. 79.—The instrument firmly grasped in the left hand, while the right crushes by screwing home.



First, nothing is more important at the outset to remember than this: namely, that quiet and slow movements of the jaws of the lithotrite in searching the bladder are desirable, because rapid movements produce currents in the urine which keep the stone more or less in motion; so that it is less easily seized than when the surrounding fluid is in a state of rest. We are apt to overlook the fact that the specific gravity of the stone is much less considerable when placed in urine than in air, and that slight currents in the denser fluid act on the position of the solid body with considerable energy.

Let it be understood that the blades of the lithotrite have entered the cavity of the bladder, and that the instrument slides easily and smoothly down the trigone, which in the living and healthy organ is an inclined plane, although quite otherwise in the atonied and in the dead bladder. In many cases the instrument in thus passing grazes the stone, and the slightest lateral movement of the blades, right or left, will determine on which side it lies. Whether the stone is felt or not, when the blades have passed gently down in the middle line until a very slight check to their movement is perceived, the lithotrite should rest there for three or four seconds, and then the male blade should be slowly withdrawn, without moving any other part of the instrument, towards the neck of the bladder, until a very slight check is perceived in that direction, followed by another three or four seconds' rest for currents to subside. Now the operator should quietly press back the male blade, without changing the position of the lithotrite, and almost certainly the stone will be seized. In other words: open; pause; close—that is all. It is necessary always to remember, when withdrawing the male blade, that it is never to be drawn out roughly, since in this action the sensitive neck of the bladder may easily be irritated.

But if no stone is thus found, the operator again withdraws the male blade as before, but inclining to the right side about 45° , and closes without disturbing the central position of the instrument; if nothing is felt, he turns to the left in like manner, and closes. It is often right to open the blades before turning, for this reason: if the turn is first made and the blades are subsequently opened, the male blade as it is withdrawn will often move the stone away; whereas, if the blades are inclined while open, the stone, if there, is almost certainly seized. It is not very common for the stone to elude the search thus far; but if it does, depress the handle of the lithotrite an inch or so, an act which raises the blades slightly from the floor of the bladder, and turn them another 45° to the left, bringing in fact the blades horizontal to the left; close; if unsuccessful, turn them gently to horizontal on the right, and close. In all these movements, if properly executed, there has been barely contact of the lithotrite with the vesical walls, at all events no pressure, nothing to occasion injury to the bladder. But if there is an enlarged prostate, causing an eminence at the neck of the bladder, or the stone is very small, or we are exploring for some fragment suspected to be present, the blades are to be reversed so as to point downwards to the floor, and the object sought may then often be secured with ease. If seeking for a small stone or for fragments, we may employ a lithotrite with short blades, which can therefore be reversed with greater ease than one with long blades.

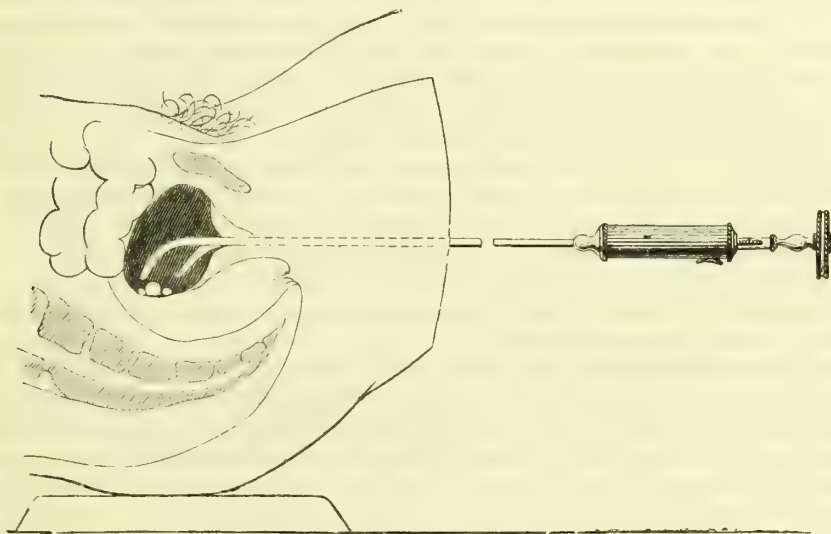
In order to do this properly, the handle of the lithotrite is depressed another inch or more between the patient's thighs, so that the shaft of the instrument, instead of being directed a little upwards, is level with, or points below, the horizon; the blades, being still closed, are cautiously brought round to the reversed position, and the floor first lightly swept, in the manner of a sound in searching for stone. Then, they may be carefully opened and closed two or three times, in slightly varied directions, but without injuring the floor of the bladder; after which an exhaustive examination of its cavity ought to have been accomplished (fig. 80). It sometimes happens, when the prostate is considerably enlarged, and a stone or fragments have to be sought behind it, that the lithotrite can be reversed without depressing the handle.

As a rule, all these movements are to be executed at or beyond the centre of the vesical cavity, the proper area for operating, without hurry, rapid movement, or any other which partakes of the nature of a jerk or concussion, and, if in a fairly healthy bladder, without causing more than a very slight degree of pain to the patient.

Nevertheless, there are many cases in which the special spot for searching with reversed blades is close behind the neck of the bladder, and with the cylindrical handle such exploration is easy and safe.

A rule has been laid down with reference to the situation of a calculus in the bladder. It is said that the larger the stone, the more certain is it to be found lying near to the neck of the bladder in the ordinary recumbent position, while a small one is usually detected at the back of the trigone. Without assenting to the accuracy of this remark, at all events in relation to the small stone, which is often close to the vesical orifice, it may be said here that the act of seizing a large stone in this position requires consideration. For if the operator commences by withdrawing the male blade according to the ordinary custom, this blade is apt to be drawn against a large stone, which it therefore fails to catch, and presses it back against the neck of the bladder, doing mischief and not succeeding. As a general rule, it may be said that the most common cause of failure to seize a large stone arises from its close proximity to the neck of the bladder (whatever position is given to the patient), and from the male blade being drawn up against it, at each opening of the lithotrite, in the manner just described. In these circumstances, the operator feels the contact of the stone

FIG. 80.—Searching for Fragments with reversed blades in healthy bladder.



without suspecting its precise locality, each time he withdraws the blade, and is apt to feel embarrassed on failing to seize it when he closes immediately after. In these cases it is essential to draw the male blade gently, but closely, to the neck of the bladder, and to slide the blade between the neck and the stone which lies in contact with it.

The rules already laid down for finding and seizing apply more or less to lithotrites of moderate size, but this general rule may be borne in mind, viz. the more powerful the lithotrite—that is, the larger and longer are its blades—the less readily are we to adopt the reversed positions of the blades, and the more fluid is it desirable to have in the bladder. As large and fenestrated blades are used chiefly for the initial act of breaking up a large stone into fragments, it is obvious also that there is less occasion for the horizontal and reversed movements, since a large stone may almost certainly be seized by the right or left incline.

Now, supposing that a hard stone of an inch and a half in diameter has fallen into the grasp of a powerful lithotrite, the screw is to be gradually turned at first, to make the blades bite, since a sharp turn at this moment may drive the stone out either right or left. As the power is increased, the resistance is felt to relax, sometimes by degrees, sometimes suddenly with a crack, and the stone is broken usually into four or five large pieces, besides some small débris. This done, the male blade

is again drawn out, taking care not to shift the situation, or alter the axis of the lithotrite, and, almost certainly, one of the large fragments will be picked up. It is then only necessary to screw home, release the screw, and open as before. This process may be repeated several times, at the same spot, for the area within which the larger fragments fall is very limited, and is unchanged if all remains quiet. The large and heavy pieces fall invariably in the same place, and may be picked up again and again, if this simple rule of keeping the blades in one place is adhered to. Having now broken up the stone, and crushed well the largest fragments, and thus occupied perhaps from ten to fifteen minutes, it should be time to employ the aspirator and remove a good quantity of débris.

Accordingly, the screw of the lithotrite is driven well home, to close the blades, between which some calculous matter probably is engaged, and the lithotrite is withdrawn. An evacuating catheter of the size known to be necessary—No. 15 or 16 amply suffices for small stones; No. 17 or 18 may be employed for larger ones, if the urethra fairly admits them—is then introduced, and all the urine withdrawn. An aspirator previously filled is then attached, the connection tap opened, and a small portion of its contents pressed by the right hand into the bladder, the left hand supporting and directing the evacuating catheter. On relaxing the pressure, an immediate current outward follows, carrying with it very probably a fair quantity of débris. Wait some three or four seconds after expansion has finished, and the current apparently ceased, as at that precise time it is quite common for one or two of the larger fragments to drop into the receiver, which would have been driven back perhaps by too rapidly resuming the pressure. This process is repeated several times, according to the amount of débris observed to enter the trap.

If the patient is breathing heavily under the influence of ether, it is desirable to inject during the act of his expiration, and let the fluid flow outwards into the aspirator during his inspiration, which act assists the evacuation of the bladder.

After a large crushing, the end of the evacuating catheter should not rest on the floor of the bladder, as it is then likely to be choked with débris. But after most of the fragments have been removed, it is advantageous to lower the end of the catheter, in order to catch the last fragments.

If the outflow of the current is felt to be suddenly checked, and the aspirator ceases to distend, the operator may be almost certain that a fragment of a rounded or cubical form, or a small calculus, nearly fitting the interior of the catheter, blocks the passage and prevents further egress. The piece must be expelled by making smart pressure on the india-rubber bottle, after which the action of the aspirator will probably be resumed.

If after crushing all the stone, so far as the operator is able to judge, and removing the débris largely, nothing is heard or felt in contact with the end of the evacuating catheters, notwithstanding that three or four successive pressures have been made, there is ground for believing that all the fragments may now have been removed. Perhaps there can be no better proof that the bladder has been emptied than is afforded by the fact that a succession of outward and inward currents through the aspirator shows no sign, either to the eye or to the ear, of the presence of another fragment.

It may be added here that evacuating catheters of different patterns should be within reach. The curve, the situation of the opening, may vary advantageously in different cases; the latter may be either terminal or lateral.

If all has not been removed, the sound of a large piece perhaps making itself heard and felt at each outward current against the end of the catheter indicates that this must be withdrawn, and a lithotrite introduced. If the fragments are not of considerable size, a lighter and handier lithotrite may succeed with advantage to the heavy fenestrated one originally used, and the crushing continued. Of course if more stone remains, the process is repeated once or more. In from ten to forty or fifty minutes, however, a uric-acid calculus of very considerable size may be thus broken up and removed. Longer than this there is not often occasion to prolong an operation.

In concluding the practical directions for the use of the lithotrite and of the aspirator, in the operation of lithotrity at a single sitting, it is to be observed that no new forms of instrument are required, although some which are more powerful and of larger size will occasionally be necessary for calculi of those dimensions which, formerly left for lithotomy, may now be crushed in practised hands. But it is never to be forgotten that, in order to achieve success, it is essential invariably to avoid, whenever it is possible to do so, the use of instruments, whether for crushing or evacuating, which over-distend and irritate the urethra and neck of the bladder. At least, the rule should be not to employ larger instruments than the size of the stone demands. The inexperienced lithotrist cannot be too strongly cautioned against the needless risk he incurs when, when in presence of a small or moderate-sized stone (and the majority met with belong to one of these two categories), he uses the heavy lithotrite and the large evacuating tubes which have of late been introduced into this country. In order to remove two or three hundred grains of calculous matter from the bladder—and many calculi weigh less than a hundred grains, while all ought to be found before they attain that weight—it is wholly unnecessary, it is even unwarrantable, to introduce lithotrites and evacuators with the diameter of No. 18 or 20 English scale into the bladder. It is certain that the splitting, for it is not dilatation, of the urethra and neck of the bladder which sometimes follows the introduction of such instruments, has sufficed to produce symptoms often distressingly painful, sometimes obstinate in duration, occasionally fatal. Surely it is more prudent to bestow two or three minutes more on the work, to ensure more complete crushing, so that the débris may be removed by a tube of 15 or 16 English diameter, than to crush coarsely and use an evacuator which infallibly inflicts serious mischief in a certain proportion of cases.

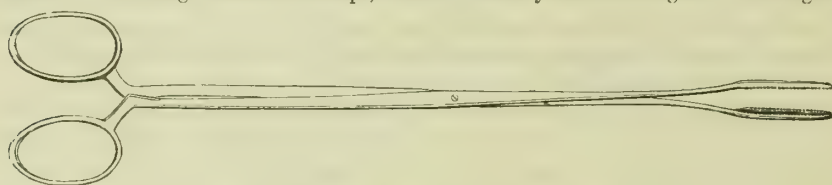
After-treatment.—When the patient has fully recovered from the ether—if suffering severely, say three or four hours after the operation, a condition by the way which is quite uncommon—a hot hip-bath, as hot as he can bear it for fifteen minutes, gives great relief. The treatment for the first three or four days in cases of large calculus is that of a mild acute cystitis: recumbent position, external warmth, frequent hot hip-baths, and small but frequent doses of solution of potash, just to neutralise the acidity of the urine. If the urethra is overstretched or bruised, an india-rubber catheter may be tied in for twenty-four hours or so, but this is not frequently necessary; while, if the bladder had previously lost the power of emptying itself, such an inlying catheter for a day or two is mostly better than frequent catheterism.

As a general rule, we find during the three or four days immediately following the operation that the relief is considerable, that the urine is clear, that the bladder tolerates a large quantity, and the aspect of the case is one of rapid and unchecked convalescence. But on the fourth or fifth day a little excitement is not unfrequently observed, the bladder becomes irritable, the urine is cloudy, and after twenty-four hours or so sub-acute cystitis is established, often destined to be troublesome for a week or two. I have remarked these phenomena so frequently that it is impossible not to look for their occurrence; and I am satisfied now that they appear in spite of precautions, and are by no means necessarily the result of an imprudence on the part of the patient. The liability pointed out, however, indicates that it is most desirable to enjoin the recumbent position, confinement to the room, a warm temperature (in cold weather), and care in every particular of management for at least some days after crushing a calculus, whatever its size.

It sometimes happens that a little débris is left behind, especially when the stone is large. This may come away by itself, and generally does so. There is now far less anxiety than formerly about remaining fragments giving rise to prolonged irritation. Since the aspirator has been used more freely, it has been quite clear that this instrument rather than the lithotrite has been the best means, not only of giving evidence of the presence of any fragment left behind after operation, but also of removing it from the bladder. So also in regard of impaction of fragments in the urethra, which only occasionally occurred, even when the results of crushing issued,

chiefly by the patient's unaided efforts, through the urethra. In such circumstances, and also when a small calculus uncrushed has become impacted in any portion of the passage, an attempt may be made to remove the obstruction; and with a well-made urethral forceps this may be accomplished almost at any depth. The long stems of the forceps should be slightly curved so as to cross each other; in this way an instrument may be constructed seven inches, or more, in length (not including the rings), the blades of which will open sufficiently to seize a fragment two or three eighths of an inch in diameter, without overstretching the meatus externus (see fig. 81). They are eight and a half inches long, and will pass to the neck of the bladder in most individuals. Furthermore, the ends of the blades should not be pointed, should not meet each other, and should be slightly scoop-shaped. With this instrument I have extracted large fragments with great ease. All that is necessary for this purpose is to commence with a fair firm hold on the fragment, and then to give plenty of time to the withdrawal, extracting as slowly and gently as possible. In this way it is remarkable how large and sharp a fragment may be safely removed, whereas by force the urethra is lacerated, and the extraction is rendered much more difficult. Sometimes it is necessary to return to the bladder a fragment situated in the prostatic

FIG. 81.—The long Urethral Forceps, drawn of exactly half the length of the original.



or membranous portions; but all on this side the last-named spot should certainly be extracted. To effect the object, a large gum-elastic bougie usually suffices; if not, a large silver catheter, the end of which is cut off, and the opening accurately fitted with an olive-shaped knob attached to a stylet, is passed down until the fragment is reached; the stylet is then withdrawn, the rim of the opening at the end of the catheter surrounds the fragment, and will remove it safely into the cavity on making pressure: sometimes a stream of water forcibly injected will displace it more readily than the instrument. Some operators prefer a small urethral lithotrite, but the simplest and most efficient instrument, since it is much more immediately under the guidance of the hand than those which are more complicated, is the forceps described above. A long cuvette, well constructed, is a very useful aid; and is in some circumstances the most efficient means which can be employed.

It is said to be occasionally necessary to cut down upon an impacted fragment, either in the perineum or near to the meatus externus. If it remains there, obstructing micturition, or if it is lodged in the soft parts surrounding the urethra, which is apt to happen in or about the membranous portion, causing much disturbance, or threatening abscess, it might be removed by incision. Up to the present time I have never had occasion to do this; although occasionally I have had to divide the inferior angle of the external meatus to set free an unusually large piece, which was arrested there. The meatus is often small, and requires to be divided; if so, this should be done at the outset of the case. On the other hand, although I have thought it right to retain these practical directions in relation to fragments, it will be clear to the reader that if the principle of clearing out the bladder at a single sitting can be realised in practice, there can be no trouble in relation to impacted fragments.

Associated with the operation are certain morbid phenomena which occasionally appear, and which must, therefore, be briefly noticed. The most common is an attack of rigors or evanescent 'febrile' attack; less commonly, acute cystitis or prostatitis; orchitis; hæmorrhage, very rarely, and retention of urine, more or less complete.

Fever.—It is not uncommon, although it is exceptional, that a sitting is followed

by a rigor, rapidly succeeded by hot and dry skin, and subsequently by sweating; at the same time there are thirst, an accelerated pulse, and augmented temperature; pains in the head or back, or in all parts of the body, not unfrequently occur also. This group of symptoms is commonly known as an attack of fever, or of 'urethral fever;' being probably often associated with some lesion, however slight, of the urethra. The attack varies greatly in intensity; it may commence in the faintest chill, or in a rigor of great severity, the subsequent phenomena generally corresponding to the initial one. In nine cases out of ten it is not of serious import, and is treated by keeping the patient warm, wrapping him up well, applying hot bottles, and giving some warm drink, as hot tea, or a little wine-and-water, if preferred. A moderate dose of opium is, perhaps, the most useful prophylactic; quinine appears to have little influence in preventing the attack. A drop of the tincture of aconite given at the time, and repeated in two or three hours, has been said to prevent rigors; but I cannot endorse the observation, for it is very difficult to judge of the effect of any single agent in these circumstances. That one in which I have the greatest faith, as a preventive, is the surgeon's ability to operate with safety, so as to injure the urethra as little as possible.

Inflammation of the bladder, prostate, or testicle.—When the attack is very severe, it may announce the onset of some local affection, as of cystitis, or of renal implication, or inflammation of the testicle, although it may still be only severe constitutional disturbance resulting from the operation, and not related to any local inflammation; in this case the fever is more likely to continue or become intermitting. If pain above the pubes, or at the neck of the bladder, and frequent desires to make water are experienced; or, on the other hand, should severe pains in the loins and sickness occur, counter-irritation to the supra-pubic region, or to the loins, respectively, is of service. I know of no better form for these cases than the repeated application of hot linseed poultices, sprinkled with mustard. Hot hip-baths, demulcent drinks, small but frequent doses of liquor potassæ, diaphoretic regimen, and mild nutriment, form the main elements of treatment; opium, if necessary, to relieve pain. When the cystitis becomes more chronic, and much pus and mucus are mixed with the urine, the bladder may sometimes be washed out daily with very weak solutions of acetate of lead or of nitrate of silver. In orchitis, which rarely occurs, fomentation and rest are necessary, and the use of a lotion, one part tincture of opium, three parts liquor of the subacetate of lead, and four parts water. I know nothing which relieves so speedily as this combination.

Hæmorrhage.—This rarely occurs; a little bleeding sometimes follows the application of instruments, and may even continue for a day or two, but this is exceptional. If it becomes severe, the usual treatment of vesical hæmorrhage should be adopted in these cases, consisting in rest, elevation of the pelvis, cold, with or without ice, ice in small pieces in the rectum, even injections of ice-water, or iced solution of matico, if the manipulation does not excite fresh bleeding. The tying-in of a soft vulcanised catheter may or may not be advantageous, which experiment alone can determine. As a rule, all mechanical expedients are to be postponed until absolute quiet and cold have proved inadequate to obtain subsidence of the hæmorrhage; since it is so much more easy to excite fresh bleeding by mechanical means than to check it.

Chronic retention of urine.—There is one condition which must always be closely looked for after lithotomy, especially in elderly subjects. It is the occurrence of retention of urine after a sitting. It may occur very insidiously, occasioning great discomfort and even constitutional symptoms, before either the patient or the surgeon is aware of the cause. The bladder appears sometimes to be temporarily atonied; it becomes full and the surplus runs over, and as the urine appears in the ordinary quantity of health, the distension of the bladder is easily overlooked. It is apparently due to defective power in the organ, resulting from the operation; or to swelling of the urethra, or of the prostate beneath it; mostly, but not always, the natural power is speedily regained, but, until it is so, the catheter must be introduced twice a day,

or more frequently if necessary, as in all cases where this condition exists from other causes.

Supposing, however, no bad symptoms to have occurred after the operation, or at most perhaps a single shiver with feverishness for a day or two has occurred, in the course of a week at any rate a little movement is permitted to the patient (often at an earlier period) by way of observing the effect of exercise on the bladder, and comparing the results occasioned with the symptoms which were previously induced by movements of the body. If walking and driving are borne without pain or frequent micturition or even discomfort, and of course without the appearance of blood in the urine, we may soon conclude that the whole of the calculus was removed; in which case a very few days will probably bring about a complete convalescence. In some cases this is longer in appearing—a condition already alluded to—and rest and ordinary treatment will generally overcome it. In a few exceptional instances, chronic cystitis is continuous and troublesome, phosphatic deposits occur, occasionally bringing about a state of the bladder which has long been regarded as the opprobrium of the crushing operation. No doubt it has in a few cases given rise to a condition demanding much patience and management to control, and which sometimes prove almost fruitless after all. The old operation by repeated sittings, necessarily occupying with a large stone a period of fourteen to twenty-one days, and a much longer term in some hands, doubtless contributed to produce an unhealthy inflammation in some bladders which would not have been so affected had the stone been removed by lithotomy.

And it cannot be said that lithotripsy at a single sitting has banished these unhappy cases from practice. One or two of the worst, and most persistent, examples of phosphatic cystitis I have seen of late years followed an operation in which I removed with great ease a small uric-acid calculus (eighty-four grains) in six minutes. Gradual improvement took place, but for a few months frequent micturition, much pain, and repeated production of phosphatic deposit were experienced. A similar case occurred about the same time, but this recovered soundly by the following spring. In several other cases there was persisting cystitis for three or four months after the operation, but not longer. All these are cases in which the calculus was uric acid, and cystitis was not present before the operation. When the calculus has been phosphatic, removed from a bladder habitually emptied by the catheter on account of large hypertrophy of the prostate, and cystitis has pre-existed, it is almost invariably much lessened by the operation; but its continued existence in such a case to some extent is often a necessary concomitant of organic changes in the organs, and involves no discredit to the surgical procedure.

But I think we may be justified in concluding that the occurrence of the morbid condition of the bladder following lithotripsy for uric-acid and oxalate-of-lime calculi in previously healthy organs, occurs less frequently now than heretofore.

Mortality after lithotripsy.—I presented to the Royal Medical and Chirurgical Society in 1877¹ a careful analysis of 422 consecutive operations of lithotripsy, performed by myself on adult male patients. Their mean age was rather above sixty-one years. The number of deaths, including all possible contingencies, was thirty-two; being a mortality of seven and a half per cent. The causes of death were tabulated and shown to be as follows: acute nephritis, pyelitis, cystitis, in the great majority of cases, often associated with pre-existing chronic disease. After these came next in order pyæmia, fatal in five cases; lastly, exhaustion, and enfeebled states of health in which the operation had been attempted with small chance, as the last resource in order to save life.

All the foregoing cases were treated by lithotripsy, performed on the old plan of one or more sittings, according to the size of the stone. A considerable number were operated upon subsequently by the same system followed by very similar results; but during the last three years my lithotripsy operations have been all concluded at one sitting, and with a mortality considerably smaller than that above named. Up to the present time I have operated on 104 consecutive cases of elderly men—that is to

¹ *Trans.* 1878, vol. lxi.

say on 104 *separate individuals*¹—no one individual having required during that period to be operated on a second time. I have included no case of mere phosphatic concretions, which frequently require to be crushed for patients who pass all their urine by catheter, urine which is alkaline and liable to deposit phosphates. These are not cases of 'stone in the bladder,' and have no right to be so regarded. The mean age of the 104 individuals is over sixty-two years and a half. The number of uric-acid calculi is sixty-two, of oxalates four, of mixed calculi nine, and of phosphates twenty-nine. *The number of deaths is three only.* This is a better result than I have ever before accomplished. I am sanguine enough, therefore, to hope, judging from this experience, that the mortality of the stone operations is reducible by the single-sitting method materially below that of any previous one. Never, I believe, has it in the history of surgery hitherto fallen to the lot of any man to operate for the stone on 104 elderly male patients with only three fatal cases. The mortality now recorded is, I confess, a better achievement than I had ever ventured to hope for.

Lithotomy in cases where the presence of calculus is associated with other diseases.—Does the operation require to be modified, or is it practicable where such complications as the following coexist?—Organic urethral stricture; atony and paralysis of the bladder; sacculation; tumours of the bladder; organic renal disease. These may be briefly considered in the foregoing order.

Stricture.—In most cases lithotomy may be employed; but when the stone is large and hard, while the stricture is narrow, tight, and of old standing, lithotomy may be preferable.

The method I have adopted for operating in presence of organic but fairly dilatable stricture is, by tying in a gum-catheter ('continuous dilatation') for a few days before crushing. When the urethra has been thus dilated up to No. 12 English scale, ether is given, the catheter removed, and as much calculus removed as the condition permits. If not removed at one sitting, the catheter is again tied in, and another sitting may follow in two or three days. The débris should be made fine, and an evacuating catheter of No. 12 in size employed to remove it. I have pursued this plan successfully in several instances, completing the operation usually in three or four sittings, with two or three days' interval between each. Of course it is necessary to use small lithotrites, and to crush finer than usual in order to remove the débris by a smaller evacuating catheter.

Hypertrophy of the prostate.—The coincidence of this condition with calculus is frequent in elderly patients, and so inconsiderable in its bearing on the operation that it is not worth taking into consideration in relation to treatment. But when the gland is very large, and when it is eccentric in form, as through the presence of polypoid outgrowths or of rounded masses into the cavity of the bladder, a serious complication is presented. Even then less difficulty is presented than might be anticipated. Careful manipulation to avoid bleeding is essential, and therefore gentle and restrained movements of the lithotrite must be adopted. Much also of the work must be done with blades reversed, deeply behind the prostatic growth; and this is not very difficult, the depression there admitting access of the instrument as readily as in the healthy bladder. The use of the ordinary catheter is often necessary for these patients as a habit; but occasionally, during an attack of great frequency in micturition, a vulcanised catheter may be retained for a few days with singular advantage; or the ordinary gum-catheter, according to circumstances. Sometimes, however, it cannot be borne.

In one case of an elderly man who had no power to pass any urine by his own efforts; and who was the subject of a large phosphatic calculus, the in-lying catheter could not be tolerated. His prostate was of enormous size, and for some years he had removed all his urine by catheter. This he was compelled to do every hour and

¹ Eighty-nine of these cases were reported, each one with the weight of stone and name of his medical attendant with whom I saw the case, in my paper on the subject at the International Medical Congress in August, 1881. The twelve remaining cases have been operated on since; January, 1882.

a half, day and night, owing to the irritation present. In this condition I first crushed and removed most of the calculus by ordinary lithotritry; I then at once placed him in the position for lithotomy, made a small median opening into the membranous urethra, dilating it with my finger, and by means of small lithotomy forceps extracted some remaining fragments, so as to empty the bladder completely. After this I introduced a short but large gum-catheter into the bladder by the perineal wound, and fixed it there; this gave him perfect relief, for he was unable, in common with most patients suffering from hypertrophied and inflamed prostate, to tolerate a catheter tied in by the urethra; but by the means described he had complete repose, and experienced no unfavourable urinary symptom whatever. My friend Mr. J. Morgan of Chapel Street, London, and Mr. Brewer of Huddersfield, were present and assisted me at the operation. I have no hesitation in regarding this combination of the two proceedings, in the circumstances described, as a valuable addition to our resources in some cases, not very uncommon, where the prostate is large, the bladder contracted, and ability to pass urine by the natural efforts is lost.

Atony and paralysis of the bladder.—With either of these two different conditions, it is by no means uncommon to find stone in the bladder. Patients who are younger than the subjects of hypertrophied prostate, find it necessary, from the causes named, to pass their urine by catheter; and when they form stone, it is mostly phosphatic in character. Here the complication can scarcely be said to increase the risk. The organs are habituated to the contact of instruments; no deformity exists; there is only a flaccid bladder and a want of tone in its coats. All that is necessary, beyond the crushing of the stone, is its removal by the aspirator in the ordinary way.

Sacculatation of the bladder.—This is one of the most serious and unpromising conditions which can complicate any proceedings to remove a stone. It is unfavourable in lithotomy, and in lithotritry is the source of failure and of danger. Unhappily, the diagnosis of sacculatation is not always possible. I have diagnosed a sac during life, and verified the statement by autopsy; but in the majority of cases in which sacs exist, I know no means of accurately determining the fact during life.

In cases of death in aged patients, occurring after lithotomy or lithotritry, especially when it occurs in subjects of long neglected chronic retention of urine from enlarged prostate, it is by no means uncommon to find sacs in the bladder. Often they are small and numerous, less frequently they are large, but in any case they seem to conduce in some manner to the unfavourable issue. They become the depositories of decomposed urine, which rarely altogether issues from them; thus chronic but dangerous inflammation is set up, and not only cystitis, but even peritonitis, may be produced, for many lie in close contact with that membrane. As a result of performing lithotritry, fragments may be caught in these recesses, where the foreign matters doubtless increase irritation, while their removal becomes impossible. Should, however, the diagnosis be clear before commencing any proceeding, it is possible, other conditions being equal, that lithotomy might be somewhat less hazardous for such a case than lithotritry.

Tumours of the bladder.—These—simple prostatic growths being of course not included in this category—are so rare, that the question of applying lithotritry for a patient with a tumour in the bladder can seldom arise. I have operated in three instances only, and in two of these the growth was cancerous. The only indication presented is to operate with extreme gentleness and care, so as to avoid hæmorrhage. In these cases, the space for operating was limited; but this, if the stone is not large, is scarcely a serious objection. Each cancerous patient lived a short time after the removal of the calculus, and his sufferings were mitigated in consequence.

Renal disease.—I have had to perform lithotritry several times for patients suffering with advanced Bright's disease. Such individuals exhibit tendency to constitutional disturbance, such as fever, irregularities in the excretion of urine, &c., more readily than those who are not so affected. It is often with no little anxiety that the symptoms must be watched in these cases. The main object of the surgeon in performing the necessary manipulations is to produce as little irritation as possible. Probably this will be in the long run accomplished as well, or better, by a single

complete sitting than by repeated small ones. All possible care should be taken of the patient's external conditions : he should be confined to his bed, or at all events to his room, and on the appearance of any fever, or of pain in his loins, hot cataplasms of linseed, sprinkled with mustard, should be applied to the back. All rapid changes of temperature should be provided against, the sufficient action of the bowels ensured, and the powers of life supported by unirritating nutritious diet.

Recurrence of calculus.—Among 500 cases operated on by myself, and analysed in a paper presented to the Royal Medical and Chirurgical Society, before referred to, there were fifty-six in which the calculus has reappeared, and in which the operation had been again performed. Let it be repeated here, that the mere removal of a few phosphatic concretions, subsequently occurring, has not been reckoned as an operation, but only the re-formation of a fresh calculus of some size after a year or more of interval since the preceding treatment.

Now, there are two ways by which calculous matter reappears after an operation of lithotrixy. First, there may be a fresh descent from the kidney into the bladder ; either of a uric-acid or an oxalate-of-lime calculus, and but very rarely of a phosphatic formation : any one of these having found its way into the bladder, if not expelled naturally, or removed by artificial means, will form in time a larger stone. This occurrence may follow equally either the cutting or the crushing operation, and does take place in a certain proportion of all cases. The descent of a freshly formed uric-acid calculus was noted in exactly twenty of the 500 cases ; the intervals between the first and second stone varying from one year to eight.

Secondly, another and a wholly different mode of calculous formation has to be described. And this is more common than the other. To a certain extent, but not altogether, it is to be accepted as an opprobrium to lithotrixy. Happily, the frequency of its recurrence is to be diminished by perfecting the crushing operation in all its details. At the same time, it is by no means unknown after lithotomy, although it is rare after that operation. It occurred in from thirty to forty cases of the 500. In certain conditions of the bladder which are wholly unconnected with the presence of stone, viz. that in which the organ is not emptied by the natural efforts so common among elderly men, chronic cystitis may arise and become the point of departure for the production of phosphatic deposits. If prolonged chronic inflammation of the bladder is produced or perpetuated, partly by the employment of instruments and partly by the presence of fragments produced in the operation, a large quantity of triple phosphate is often rapidly formed, and becomes a more or less persisting deposit. If neglected, fresh calculus is very likely to result. No doubt in some cases, by much care, by emptying the bladder daily, injecting it, &c., this reproduction may be prevented. In some constitutions, the tendency to produce phosphatic deposit thus is much more marked than in others : a small degree will give rise to it in some individuals ; a very large degree will fail to do so in others. It is unquestionably a sequence of lithotrixy which is diminishing, and will diminish, in the same ratio that the operation itself becomes more perfect.

Lithotrixy in children.—Lithotrixy can be applied to patients of any age ; but there are some difficulties in its employment in the cases of children which those of adults do not generally present.

The urethra of the child, say from three to seven, or eight, years, is exceedingly small, and it is during this period of life that half the cases below puberty occur. To crush a stone at this age it is, therefore, necessary to employ a very small lithotrite. Hence, none but small stones are amenable to its action, for in a small lithotrite, the blades must be short, otherwise they are liable to break ; and short blades are incompetent to grasp any but small masses. If used to break down piecemeal a stone of an inch diameter, the time consumed is considerable. Hence in Paris, where only lithotrixy was some years ago largely employed for children, ten, twelve, or more sittings were common. Moreover the structures are very delicate, and easily injured by the passing of many instruments, or those which are relatively large to the passages traversed.

Incontinence of urine after lithotritry in children is not a very uncommon result, although it generally disappears spontaneously in course of time.

If it is decided to operate in any given case, the urethra should be dilated on three or four occasions previously, the pelvis should be well elevated; and if the stone, when caught, proves to be no larger than a large pea, it should be efficiently crushed and evacuated at a single sitting, care being taken to granulate it thoroughly. Providing it is thus small, the proceeding is generally successful. The child should be confined strictly to bed, have plenty of demulcent drink, an opiate if much straining follows, and warm baths. In cases of my own, in which the stone was quite small, I have crushed it at a single sitting. Such a result must be regarded as a simpler and safer proceeding, probably, than lithotomy. But certainly where more than two sittings are necessary, the advantage of lithotritry appears to be very doubtful. The instrument I used, in that and in other cases, is one without a screw; the crushing power being obtained by simple pressure in the palm of the hand; and this is ample for the small concretions to which it is applicable.

Boys, from nine to thirteen, are somewhat more promising subjects, but in them the same sources of difficulty exist, though in a less marked degree.

At the conclusion of our subject we have only to consider briefly to what cases of stone in the bladder is lithotritry applicable, and for what cases is it unfitted.

For all cases of calculus during the periods of infancy, childhood, and boyhood, which may be regarded as from one to twelve or fourteen years, it is desirable to practise lateral lithotomy as the rule, the mortality from which varies during this period from one in eleven to one in twenty-eight cases; the mean of the whole being about one in fifteen cases. But there are exceptional cases in which the stone is only a little too large to pass by the urethra, and therefore small. For these, we may perform lithotritry.

When the stone is so small as to be easily pulverised at a single sitting by a slender lithotrite, it is the simplest and best method of proceeding, and ought to supersede the cutting operation. But after the age of puberty has been attained, and throughout the entire range of adult life, lithotritry at a single sitting must be accepted as the one operation, applicable in the large majority of cases, with only a few exceptions. When the operation by multiple sittings was universally practised, several considerations presented themselves, which rendered not infrequently lithotomy the most acceptable, that is, the most judicious proceeding, in the interests of the patient. But after the experience which I have attained, and have been enabled to exhibit, there is for myself no hesitation in advising, that for all stones, both great and small, hard and friable, and at all ages, after puberty has been passed, the one sitting operation, with instruments always conformable to the requirements of the case, and in fairly practised hands, is by far the most successful procedure which has been yet employed in the history of surgery.

The only exceptions are those which consist in extreme size, with hardness of structure in the calculus itself, and confirmed narrowness or other obstruction in the urinary passages, rendering the employment of adequate instruments impossible. In either of these two conditions, lithotomy in some form, or in combination with crushing, would be necessary.

It is difficult to say what size with hardness would be insuperable by a lithotrite. Size with friability, as in phosphatic formations, could scarcely be regarded as insuperable, given time and space to operate in. In uric-acid formations, the largest I have yet attacked was one which I removed from a gentleman, aged 69, whom I saw throughout with Dr. Travers of Kensington in January 1882. It was a very hard and compact formation; the débris weighed two and three-quarter ounces, and occupied me one hour and ten minutes. Not a fragment was left behind, all being removed at the one sitting. He had no fever or other bad symptom, and was convalescent in a fortnight, and quite free from all symptoms of stone.

In oxalate of lime, the largest I have at present crushed, also a most successful

case, brought to me in 1880 by Dr. Harris of Brixton, the débris weighed one ounce and three drachms. The patient is at this moment enjoying life and excellent health for a septuagenarian, and without any return of symptoms.

On the other hand, the crushing operation at one sitting should be employed by beginners only for calculi of moderate size, when they are hard. If calculi are as large as the foregoing, a young surgeon will probably proceed more safely by lithotomy. Lithotritry at a single sitting, or even at many sittings, for a hard calculus upwards of an ounce in weight, and, *à fortiori*, when double that weight, certainly demands an experienced operator.

Regarding those very rare cases of calculus, now happily growing rarer year by year, which are occasionally met with, weighing from four to eight ounces, and of dense compact stricture, probably lithotritry may at present be scarcely competent to deal with them. But lithotomy in any form involves a risk which is necessarily great.

One thing still is certain, and never to be lost sight of by the surgeon, viz. that success in lithotritry is proportionate to the small size of the stone to be dealt with. Hence the extreme importance of discovering its presence in the early stage of the formation. For I will not hesitate to affirm that lithotritry for a moderately small stone, whether friable or compact, occurring in any ordinarily healthy adult, is, if properly performed, an operation almost absolutely devoid of danger. Such a statement cannot be made of any other mode of operating for stone. In proof of this I am in a position to assert that, having now performed the operation some hundreds of times, I have lost but one patient in whom the calculus was no larger than a small nut, and he was the subject of renal disease.

It follows then—since every calculus is during a portion of its history small, and passes, generally, not very rapidly, through the early stages of formation; that calculus of the bladder is removable, if its presence be diagnosed at an early period, in almost every case, with little or no danger.

No proposition can be more logically incontrovertible than this: yet the practice of the past, so far as it depends on progress in the art of diagnosis, though steadily improving, has done so by slow degrees. When, however, the truth it contains is generally understood and exercises a wide influence on practice, an important diminution in the mortality from stone operations must necessarily follow. In this department, as in every other of the wide domains of medicine and surgery, diagnosis is the one thing needful. That diagnosis is slowly reducing the size of the stone year by year, and has been doing so during some time past, is demonstrable from our museums. Lithotomy for the adult is already almost a thing of the past; it ought to become so altogether and speedily. The ‘Operation for the Stone,’ one of the most formidable ordeals which a patient in the first quarter of the present century could be called on to encounter, and in prospect of which he always made the last prudential arrangements for those who might in these circumstances so soon succeed him, is bereft of its terrors, and ranks with the most certain and the most perfectly successful triumphs of modern surgery.

HENRY THOMPSON.

CALCULUS IN THE FEMALE.

THIS is a much rarer affection than calculus in the male; and more so in children than in adult females. To a great extent, but by no means entirely, this difference is due to the short urethra of the female, which facilitates the natural expulsion of gravel and small calculi. Partly, because the lives and habits of men differ greatly from those of women, the latter are certainly less liable to form uric-acid and oxalate-of-lime calculi. Added to this is their exemption from chronic retention of urine due to atony and prostatic disease, the fruitful occasion of phosphatic formations among elderly men.

The symptoms of stone are the same in both sexes; the female complaining also of what are known as 'bearing-down' pains, and also often of incontinence of urine. The symptoms sometimes simulate those of uterine disease, for which they may be mistaken; a fact not to be overlooked when signs of disease in adjacent organs co-exist and the diagnosis is not clear.

Sounding may be performed with the same sound as that recommended for the other sex; but if preferred the shaft may be shortened some three or four inches, not without advantage. The calculus is not so uniformly met with near the neck of the bladder in the female as in the male: it is indeed not unusual to find it either right or left of the middle line, in either lateral division, as it may be described, of the bladder, and to be able to touch it by turning the beak well in either direction. Sometimes the introduction of the finger into the vagina brings a stone into contact with the sound, and enables the surgeon to estimate the size, &c.

Calculi may be removed by dilatation of the urethra and extraction by lithotripsy and by lithotomy.

1. *Dilatation of the urethra.*—When the calculus is small, there is no objection to making a moderate dilatation with large sounds, the finger, and with a Weiss's dilator, the blades of which are sheathed in an india-rubber tube; as when thus guarded a greater degree of dilatation may be accomplished with less of that rupture which always follows mechanical dilatation carried beyond a certain limited extent. It should be borne in mind that an undue amount of rupture is liable to produce incontinence of urine, a condition from which some patients do not readily recover; and that there can be no motive now for employing such treatment, as lithotripsy offers an easy method of reducing and removing the stone without injury to the passages. Hence dilatation should never be employed for any calculus larger than a small nut, or a large bean in an adult, which limits its application to a very few cases. If in any circumstances dilatation is to be employed for a stone of medium or large size, rapid dilatation, which is in fact rupture, has been found preferable to slow dilatation, which appears to inflict more lasting injury than the former on the soft parts. In children and young subjects calculi should certainly be crushed.

Lithotripsy.—It follows then that with the present mode of conducting this operation, already fully described, stone in the female may be crushed or removed at one sitting at least as readily, if not more so, than in the male subject. The passing of instruments is much more easily managed by most surgeons: the only difficulty, if it be one, consisting in the speedy spontaneous evacuation of the fluid contents of the bladder during the operation. With proper lithotrites—that is to say, with instruments constructed so as not to injure the soft parts—the fact mentioned is of very small importance. No special instructions are requisite; and anyone who can perform lithotripsy on the male has nothing further to learn in relation to the operation on the female. A well-conducted etherisation, the usual position and free access are neces-

sary, if the stone is rather large. All débris are of course to be washed out at once; and the treatment subsequently follows as directed for the other sex. The convalescence, however, is in the former class more certain, steady, and rapid, as a rule, than in the latter.

Lithotomy.—As this operation is a much more simple and easy one than lithotomy in the male; and as it is far less dangerous also, there is no reason why the propriety of performing it should not be considered, when the stone is rather unusually hard and large. While in the male adult, the cutting operation is always associated more or less closely, according to the age and the condition of the subject, with the question of mortality, this aspect hardly presents itself in the cases of women. In these the surgeon chiefly dreads, after removing a large calculus by incision, an imperfectly healing wound, and insuperable incontinence afterwards, a never-ceasing occasion of annoyance or even of grief both to the patient and to himself. It is this unhappy condition that lithotripsy avoids, and a preference for the latter procedure is natural and just for all cases within its reach.

Supposing, however, that the cutting operation must be accepted for a calculus which is too hard and large to be crushed, the method of performing lithotomy in the female must next be considered.

The bladder may be opened from the urethra by an incision directed from the canal outwards, horizontally to the left, or obliquely downwards, as in the lateral operation; or, indeed, in any direction preferred. Or a direct opening may be made into the bladder from the vagina, and the stone removed by that route, without wounding the urethra in any way.

The necessary incisions are simple, easy to make in either case; but the treatment of the opening is the most important part of the operation. On the first-named plan, the wound should be carefully united throughout its course by sutures, and a soft elastic catheter left in the canal, by which the urine should flow freely and spontaneously for a few days, being carefully watched by the nurse to prevent blocking and distension of the bladder with urine. The bowels should remain constipated for a week or thereabout. On the second plan, the wound may be treated at once as for vesico-vaginal fistula, with similar precautions. It is difficult to say which of the two methods is preferable: so much depends on the management and after treatment in each case, in order to ensure sound union, or nearly so, of the parts.

The preliminary steps of the operation are, the ordinary position as in the male, and to provide a short grooved staff, scalpels, gorget, lithotomy forceps, wide spatulas for holding aside the parts, a vaginal speculum, &c.

I have myself removed several calculi by the lateral oblique section, made from the urethra, some of them very large; and I have good reason to be satisfied with the results. There was one case only of death, the cause being pyæmia.

In a single instance I performed the suprapubic operation for a young woman, in order to remove a large hair-pin which had for some time been firmly fixed across the bladder, and which I failed in consequence of its position to remove by the urethra.

The few cases of lithotripsy which I have performed have been completely successful, and I shall adopt this operation as the rule in future.

*Calculi in the bladder, obstructing labour.*¹—The accoucheur may not be aware until the period of labour of the presence of obstructing calculus. And this may be found either before the presenting portion of the child or between it and the arch of the pubes, forming an impediment to the progress of the fœtus. Should the calculus, during descent of the head, remain at the upper part of the vagina, delivery will not be impeded; and the head, as it passes through the pelvis, will itself prevent any future obstruction; but if the calculus fall into the neck of the bladder and be placed below the head, the labour will be rendered difficult.

In the 'Edinburgh Medical and Surgical Journal,' vol. xxxi. 1829, there is a report of a case by which the passage of the fœtus was obstructed by a stone in the

¹ Lever, *Guy's Hospital Reports*, 2nd series, vol. i. p. 51.

bladder, which was found to weigh 6 oz. 5 dr. and 3 grs., its measurement being $3\frac{5}{8}$ inches long, $2\frac{7}{8}$ broad, and $2\frac{1}{2}$ thick. The nature of the case was not properly understood, no catheter was passed to ascertain the state of the bladder, and the child's life sacrificed by perforation.

Velpeau ('Art des Accouchemens,' vol. ii. p. 208) relates a case in which a calculus weighing $9\frac{1}{2}$ oz. was removed from the bladder of a woman four months advanced in pregnancy, who was afterwards delivered without any difficulty.

Treatment.—If the calculus be discovered during pregnancy, it should be removed before labour commences; extraction may be practised with safety during gestation. If not detected until the patient be in labour, and if the calculus be small or if seated in the cavity of the bladder above the head of the child, the case may be left to the natural efforts. But if the stone be large, or if it be placed below the head of the child, we must have recourse to some method of removal.

(a) In some cases the stone may be replaced, or rather may be pushed back into the cavity of the bladder above the brim of the pelvis. This *reposition* is recommended by Smellie, Denman, Baudelocque, Dubois, &c.

(b) When the calculus is fixed and does not admit of reposition, it must be extracted in one of three ways: 1st. *Dilatation of the urethra*. 2nd. *Lithotomy*. 3rd. The high operation, or *suprapubic lithotomy*.

HENRY THOMPSON.

VENEREAL DISEASE.¹

‘La syphilis devrait servir de clef à toute la pathologie.’—ANDRAL.

CHAPTER I.

INTRODUCTION.

WHEN venereal matter is applied to the surface of the human body, no appreciable effect in general results; but when the poison comes in contact with the thin skin in those situations where it joins the mucous membrane, or when applied to the mucous membrane itself, or to the skin in places where the epithelium has been removed, then inoculation may take place. As observed in practice, the results of inoculation afford considerable variety; when artificially performed, they are much more uniform.

Four distinct and well-marked morbid processes may follow syphilitic inoculation:—

1. The inoculated part may become affected with the ‘adhesive form of inflammation,’ in which lymph is poured out either in the substance or on the surface of the part.

2. The absorbents may assume an active share in the morbid process, taking up some of the infected parts, and with them portions of the venereal poison. This process will, in the following pages, be called ‘lymphatic absorption.’

3. The inoculated part may, within a few days of the application of the poison, be affected with suppurative inflammation; and

4. The morbid action may terminate in mortification. Of this there are two practical subdivisions:—

(a) Death of the whole infected part, which is then thrown off as a slough; and

(b) Dissolution and death of a part only of the contaminated structure, leaving a part still infected.

These four kinds of morbid processes, essentially distinct when once developed, usually maintain their original character until the termination of the disease. Thus the specific adhesive inflammation may be recognised by its characteristic induration often long after the sore (which usually accompanies it) has permanently healed. But it will, nevertheless, occasionally happen that the action will become changed, and this altered condition (if careful attention be not paid to it) will lead to an error in the diagnosis. A sore affected with adhesive inflammation, upon the application of some fresh irritant may become a suppurating sore. The superinduced action may perhaps modify, but will not prevent, the specific results of the original disease; or again, a sore that has presented for a time the characters of the suppurative inflammation may alter its appearance and assume those of the adhesive form. In such a case, the first disease will not prevent the constitutional effects of the second.

Both these forms of action will constantly be accompanied by ‘lymphatic absorption;’ and the disease in the lymphatic glands will be of the same nature as that from whence the absorbed product was derived. It will also sometimes happen that

¹ In the following essay the term ‘syphilis’ will be used to denote a disease which affects a patient’s constitution; ‘venereal disease’ will be used in a more general sense.

the specific adhesive inflammation may terminate in mortification, or that a part superficially mortified may become affected with specific adhesive inflammation. In either case, the mortification may be superficial or extend to the whole of the infected tissues; but if the specific adhesive inflammation has once taken place, its effects upon the constitution will subsequently appear.

The above four kinds of diseased action, resulting directly from the application of the venereal poison to the surface of the body, may be clearly traced both after artificial inoculation and by attentively observing the natural course of the disease in different instances. It must always be borne in mind that the character of a sore at one time is no certain indication of what it may previously have been, or of what it may ultimately become. In the mode in which the disease is usually communicated, a part may be subjected to influences which would have a tendency to produce more than one morbid action. Such influences may be applied either at the same or at different times. When applied at the same time, a twofold inoculation may occur on the same spot; and if the consequent respective actions require different times for their development, one disease may first run its course, and be subsequently followed by the other, which will then go through its different stages, modified perhaps, but not altered, in its essential characters, by the first.

The number of poisons which may produce morbid actions in a part scarcely admits of demonstration. Two different poisons may sometimes produce the same action. Thus, the secretion produced by the puncture of a foul lancet, and that arising from an injury to a portion of cancellous structure of bone, may both give rise to erysipelas; or, on the other hand, the same poison may, under different circumstances, give rise to more than one kind of morbid action.

It does not, then, follow that because we can distinctly trace so many morbid processes, that there are the like number of morbid poisons. The *diseased actions* we can trace with great precision, and can predict the circumstances under which they will occur, and define distinctly the laws by which they are regulated and controlled. It is, therefore, more in accordance with strict inductive science, simply to describe the different *modes of action* which occur after impure contact, than to ascribe each different action to a different poison.

Hunter believed that gonorrhœa was always produced from the same virus as syphilis, and nearly all the practitioners who followed him were of the same opinion. Swediaur, however, remarks that the happiness and tranquillity of many families, not less than the fatal effects arising from the improper treatment of this disease, seem to demand the most careful researches upon the subject. He had convinced himself, from well-authenticated experiments, and numerous cases attended with the greatest care, that those who maintained that gonorrhœa and syphilis were always the effect of the same poison, and those who held an opposite opinion, were both wrong in generalising too much, and in speaking so positively and so lightly on a point of so much importance to the physician and the patient. He had, as he believed, proved to demonstration that blenorrhagia of the genitals of the two sexes owed its origin sometimes to the venereal or syphilitic virus properly so called, and sometimes to some other acrimony applied to the urethra or the vagina. Several cases are related which go to prove that a discharge may be syphilitic or produced by the syphilitic virus; and, on the other hand, cases are given to show that blenorrhagia is generally very different in its origin and nature from the disease produced by the syphilitic poison. It will easily be conceived, he remarks, of what importance this distinction is in practice, when, on the one hand, we see practitioners treating all gonorrhœas as venereal (syphilitic) with mercurials; and, on the other, by an ill-founded theory suffering the syphilitic virus to be communicated, and the disorder propagated through whole families, without giving themselves any trouble as to the unfortunate results. This, in a few words, gives perhaps the best account of the theories of the nature and treatment of syphilis extant in 1821.

In 1838, Ricord's *Traité pratique sur les Maladies vénériennes* appeared, and this must always remain a most important epoch in the history of syphilis. Ricord professed to demonstrate the truth of his views by experiment, and offered his experi-

mental illustrations to all who might wish to witness them. With triumphant success, and to the satisfaction of his admiring pupils, Ricord demonstrated daily the great fact, that when pus was taken from the urethra in a case of gonorrhœa, and inoculated upon the patient, no result followed; whereas when pus was taken from a suppurating sore, and inoculated with the point of the lancet, a suppurating chancre was always produced. A great triumph had here been achieved. Science had vindicated her right not only to distinguish between different morbid processes, originating apparently in the same way, but also to reproduce some of these actions, and experimentally to trace them through their various stages. With the light thus derived from experiment, the following conclusions were arrived at by M. Ricord :—

1. A chancre is known for certain, neither because it has appeared after a suspicious contact, nor on account of its situation, nor because it has an indurated base, nor on account of its colour, its shape, the character of its edges, nor by the red areola by which it is surrounded, but by its being inoculable so as to reproduce exactly the same disease again upon the same patient an indefinite number of times. All the other conditions may vary; this alone always remains the same, and affords the same experimental results.

2. The pus of a chancre can alone produce a chancre.

3. The best way to produce a chancre is to inoculate some of the secretion from its surface upon another part of the same patient's body.

4. Beyond the contact of the pus introduced beneath the cuticle, no other action is necessary to produce a well-developed chancre.

5. The inoculation never fails when the pus is taken under the necessary circumstances, and is properly applied.

6. The pus taken from an inoculated pustule will reproduce a chancre of the same kind, originating in the same way, and thus the propagation may extend from pustule to pustule.

7. When several inoculations are made from the same suppurating chancre, each one gives rise to a separate pustule, which subsequently becomes a chancre. If three punctures are made, we do not see one succeed and another fail. The number accurately corresponds with, and is never more nor less than, the number of the inoculations properly made.

8. The pustule, and the chancre which succeeds it, are always developed upon the precise spot where the inoculation is made, and never upon any other part.

9. Whatever different forms the suppurating chancre may ultimately assume, its course, in its origin, is always the same. The appearance of the pustule is absent only when the part has been excoriated; and it is preceded by phlegmonous inflammation only when the poisonous matter has been introduced into the subcutaneous areolar tissue, or has found its way into the lymphatic vessels.

10. There is no period of 'incubation,' in the sense in which this word is generally understood. There is for the suppurating sore but one process of development, from the contact of the contagious pus to the formation of an ulceration.

11. The chancre is in its origin a local disease.

12. The origin of the affection must date from the period of contact, and not from the time that the patient perceived the disease.

Such are the results of M. Ricord's investigations published in 1838, and they furnish a very faithful abstract of the evidence which he had obtained by his experimental mode of investigation. Every conclusion is based upon direct observation; and if there had been one form of venereal disease, and one only, M. Ricord's conclusions must have stood the test of subsequent experience. But it has now been proved by numberless observations, and by more direct experiments than may, perhaps, be justified, that the venereal action which arises after contagion is not always the same. The specific pustule, it is true, when inoculated, will as a rule produce the specific pustule; but there is another form of disease, of far more importance to the patient, which does not begin with a pustule at all; which cannot be re-inoculated as a rule upon the patient who has it; which often has a prolonged

period of incubation ; which cannot be destroyed by caustic, and which is followed very certainly by secondary symptoms.

The two actions now mentioned have unfortunately, up to a recent period, been confounded together. It will now be my endeavour to distinguish accurately the symptoms which belong to these two essentially different morbid processes, and to describe each as a separate affection.

M. Ricord's description, then, applies in general very accurately to the local venereal sore ; but it does not apply to that which, in its origin, does not begin with a pustule, but which begins with some adhesive form of inflammation—such as a papule, a tubercle, or an abrasion with a thickened base.

In the next chapter the suppurating venereal sore, and in the chapters following the disease which gives rise to the hard chancre, and its consequent constitutional or secondary symptoms, will be considered. The results of *twofold* inoculation as they present themselves in nature, under different forms, will subsequently be described, together with the various complications which may thence arise.

CHAPTER II.

SUPPURATING VENEREAL SORE.

THE *venereal suppurating sore* is a local disease, and is not liable, when uncomplicated, to infect a patient's constitution so as to produce secondary symptoms. It commences, when artificially inoculated, as a pustule, and runs a definite course. The inoculated point becomes red within the first twenty-four hours. From the second to the third day it becomes slightly raised, and is surrounded by a red areola. Between the third and the fourth day it contains a fluid more or less turbid. From the fourth to the fifth day the pustule becomes fully formed, and from this time to the termination of the disease, in its active state, the secretion consists of well-formed pus. Sooner or later, the cuticle covering the pustule is detached, and in some instances it may be removed at the time of the inoculation, whether artificial or natural. This alters the appearance of the affection, but in nowise interferes with its essential characters. As soon as suppuration commences, there is a loss of substance in the part, and an ulcer forms, which has peculiar characters. When not interfered with by any accidental causes, it increases equally in every direction, so as to form a more or less perfect circle. The edges of the ulcer are cleanly cut, and present a sharp outline (fig. I.) The appearance presented is often that of a piece of skin having been removed by a punch. The edges of the ulcer are frequently slightly undermined and everted. The surface of the ulcer is irregular, sometimes presenting granulations, at other times the appearance of having been worm-eaten. Often the bottom of the ulcer is covered by an adherent, greyish, tough matter, which probably is a part of the natural texture which has undergone a kind of molecular necrosis, and is in process of being separated from the subjacent living parts.

Suppuration in itself does not necessarily involve a loss of substance, but these suppurating sores nevertheless generally leave permanent and depressed scars. This evidence of loss of substance is probably in exact proportion to the degree in which the form of molecular necrosis above alluded to has been present in any individual case. The suppurating venereal sore gradually increases during a certain period, then remains stationary, and finally heals. The latter process is indicated by the base of the sore becoming clean and covered by red granulations, by the red areola which surrounded it becoming fainter, and by the edges of the wound gradually losing their prominence.

Such is a description of the typical form of a suppurating chancre ; but this may be modified by various accidental causes, of which the following are some of the most important :—

1. If the specific pustule be destroyed by the application of caustic within the first five days of its existence, a simple ulcer alone will remain. This will then have none of the characters of the specific disease.

2. When a chancre during its progress meets with tissues of different natures, or when folds of the same texture are involved, its shape and appearance may be thereby modified.

3. Should the specific inflammation extend to the areolar tissue, a certain amount of inflammatory exudation will there take place. This will produce an induration at the base of the chancre, which will then sometimes very much resemble the induration that ordinarily accompanies the infecting chancre. The latter will be particularly described in the next chapter. The induration that surrounds the suppurating sore gradually fades towards the circumference to the consistency of the neighbouring parts. When this inflammatory exudation, however, in its progress meets with a different kind of tissue, it may terminate quite abruptly, and then it may be impossible to distinguish, by the touch alone, this kind of induration from that of a chancre which infects a patient's constitution. The character of the secretion of the sore, or its inoculability on the same patient, or the history of the case, must then be relied upon to distinguish the disease.

CASE.—A patient, who considered himself well informed upon the subject of the characters of an infecting sore, presented himself in March 1859. He had a sore on the right side of the frenum, which spread ultimately for about three-quarters of an inch along the urethra. As the sore extended, it became surrounded by considerable induration, and this, as it approached the urethra, terminated quite abruptly. It was then impossible to distinguish this induration from that which accompanies an indurated infecting sore, and the patient believed that his affection presented all the characters of a true Hunterian chancre. The history of the case and the character of the secretion furnished, however, different testimony; and the patient was prevailed upon, not without very considerable difficulty, to be treated for a local disease. I ventured to assure him that his constitution would not be affected; and I had the satisfaction of seeing him on November 5, 1860, and again on February 21, 1862, without his having been subjected to any constitutional treatment, and without his having had any secondary symptoms.

4. The most remarkable accidental circumstance which modifies the course of a suppurating chancre is the absorption by the lymphatic vessels of a portion of the affected tissues, or of the secretion which they have produced.

Lymphatic absorption of the product of a suppurating venereal sore affords the same evidence of the nature of that sore as does artificial inoculation. The secretion transferred to another part is followed by the same effect, whether artificially conveyed by the point of a lancet or by the natural process of lymphatic absorption. In either case, where the seed takes root, there will it germinate and produce its natural consequence. The morbid process which ensues terminates surely, and without any period of incubation (in the ordinary acceptance of the term), in the formation of a small quantity of matter which always has peculiar properties. This matter is *pus*, and pus which has the property of always reproducing its specific action when again applied to another part of the same body, or when inoculated upon another person. This pus is therefore called *specific*. To the naked eye and to the microscope it presents all the characters of ordinary pus; but it has, in addition, its specific qualities, which are known only by their effects. It presents, as seen by the microscope and even by the naked eye, characters which distinguish it from the secretion of the indurated sore, or of syphilis. It consists of well-formed pus; and each globule is of nearly the same size, and distinct from the rest. If, in any doubtful case, some of the secretion from a sore be mixed with a little dilute acetic acid and placed under the microscope, the distinctive characters of the pus-nuclei will be seen, as represented in fig. II. The appearances produced are quite distinct from those which are afforded by the secretion from an infecting sore treated in the same manner, as will be more fully shown in the next chapter.

When this specific pus has produced its natural effect either in a lymphatic vessel or in a lymphatic gland, the fresh portion of pus thus generated produces a fresh specific irritation, and this irritation produces an abscess which, breaking externally,

discharges its contents. In such a case the matter in the interior of the gland, or lymphatic vessel, constantly retains its specific characters; but that which during the process of suppuration is formed outside the vessel or gland is ordinary non-specific pus. As the disease advances, these two secretions may be mixed together, and then the whole acquires the characters of the specific fluid, and the surface of the whole sore will become inoculated.

Lymphatic absorption from a suppurating venereal sore then necessarily produces a suppurating bubo. Any attempt to prevent such an affection from suppurating is entirely futile. The disease within the lymphatic system is the same, and runs a similar course as that upon the surface of the body.

The disease now described is not beneficially influenced by mercurial treatment; and inasmuch as it has no tendency to infect a patient's constitution, any mercurial treatment in order to prevent such an infection is entirely superfluous. The suppurating venereal sore will sometimes be tedious in healing, and a variety of applications may be tried sometimes without producing any apparent effect upon the course of the disease. In a case lately under my own care at St. George's Hospital, a sore of this nature lasted four months, apparently little influenced by treatment; but the patient at the end of that time made a very good recovery, and now remains well without having taken any mercury.

The suppurating syphilitic sore has been often repeatedly inoculated for the supposed purpose of producing what has been termed *syphilisation*. But, inasmuch as the disease, however often repeated, remains a local one still, no constitutional or permanent effect can be produced in this way; still less can any condition of the system be produced which would render it insusceptible to the infecting form of the disease. It must, however, be admitted that when a patient has already constitutional syphilis, the symptoms which have developed themselves will often disappear under this so-called syphilisation. It is principally efficacious in diseases of the skin, and these are probably removed, under the circumstances, in consequence of a kind of counter-irritation produced by the repeated inoculation of the venereal matter, and suppuration of the inoculated points.

One very important and interesting fact will require especial notice with regard to the so-called syphilisation, viz. that after repeated inoculations have been made on a part, that part becomes less and less susceptible to the influence of the poison, and a time arrives at which the inoculations will cease to secrete pus, and then they will no longer be inoculable. If fresh matter, however, be used, the inoculations will again succeed; but these will gradually lose their effect, as at first. This process may be repeated until a part is no longer susceptible to any inoculation from the secretion of a suppurating venereal sore. But then a fresh part may be inoculated, and the same process repeated. Under this mode of treatment it is said that a time ultimately arrives at which no further inoculation can be effected from a suppurating sore upon any part of the body. Even then, however, after the lapse of a certain interval, the suppurating venereal sore may again be communicated, but always without imparting any constitutional or syphilitic taint to the patient. This subject will be considered more at length in the chapter on 'Syphilisation.'

CHAPTER III.

SYPHILITIC INFECTION.

SYPHILITIC infection of a patient's system, as far as it can be traced by local symptoms, commences as a crack, an abrasion, or a pimple. These affections, in the *origin*, are often extremely difficult to recognise. They frequently do not present any characters by which they can be distinguished from similar results arising from a variety of accidental causes, and they may be masked by the coexistence of other local venereal complaints.

Syphilitic infection therefore on its first appearance generally attracts but little attention. It is attended with no inconvenience, and the patient is willing to believe that it is 'nothing'—an opinion which has been but too often endorsed by the surgeon. As the disease declares itself, it assumes one of three forms, which are all modifications of the adhesive kind of action :—

1. The cuticle may appear as if peeled off from the upper part of the glans penis, or a circumscribed patch may remain for days together, presenting a livid or purple colour (fig. III.) The structures below are not infiltrated, and therefore there is no specific induration. The secretion, consisting of epithelial scales and lymph-globules of various sizes, and more or less perfectly formed, is thrown off from the surface. In women there is probably a corresponding affection of some parts of the mucous membrane, not accompanied by induration; but on account of the difficulties attending the investigation of these complaints in their origin in females, such a condition has not hitherto been described.

2. An indurated tubercle, without ulceration, may form in the skin or under the mucous membrane, and will then present all the characters of the specific induration with an increase of substance (figs. III. and V.)

3. The most ordinary form of syphilitic infection is that which has been called the indurated or Hunterian chancre. In this a deposit of lymph occurs in the areolar texture of the skin or of the mucous membrane, and is succeeded by a process of molecular necrosis, by means of which the newly deposited matter is in part thrown off, and an ulcer is formed; but, inasmuch as it is the newly deposited material which alone perishes, no depressed scar or permanent loss of the natural tissue occurs. The secretion from an infecting chancre, when the disease is not accompanied with irritation from any accidental cause, is not pus; it consists of epithelial *débris*, of globules of lymph more or less perfectly formed, or of these same products undergoing disintegration, and of serum more or less turbid. These different products may often be found matted together, mixed occasionally with a few pus cells. During the time that the adhesive matter is being thrown off from the surface, or whenever a part has been irritated by an adherent scab, or by the application of lotions, some suppuration may take place; but as soon as the accidental cause of irritation has been removed, the natural non-puriform secretion alone remains. If the secretion from an uncomplicated infecting sore be placed upon a piece of glass, and a drop of dilute acetic acid be added, the microscopic appearances will be found to be very different from those which were described in the last chapter as characteristic of the secretion from a naturally suppurating sore. Fig. IV. represents the appearances of some of the secretion from an ordinary infecting sore, examined in the manner above described. In this case the sore, which was in a state of progress, had been dressed with water dressing, in order to prevent any accidental cause of irritation, for two or three days previous to the examination.

In debilitated and unhealthy constitutions infecting sores will suppurate as any non-specific lesion would do, and in such cases it is sometimes very difficult to distinguish the secretion produced by the local disease from that which depends upon constitutional peculiarity.

The three forms of infection now described are all modifications of the adhesive form of inflammation; and there is much reason to believe that the first two have not been recognised by a large majority of the writers on syphilis, and that hence a number of cases have been erroneously recorded, in which constitutional syphilis was supposed to have been acquired, without any primary affection.

The induration which accompanies the second and third form of the specific adhesive inflammation is peculiar, and, when well marked, it furnishes a diagnostic test of the nature of the complaint. It surrounds the edges and base of the chancre in every direction to nearly an equal extent. It terminates quite abruptly in the surrounding tissue; so that it not unfrequently affords the sensation as if a foreign substance, such as a piece of cartilage or half of a pea, had been introduced into the substance of the skin (fig. V.) This induration depends upon the effusion of lymph into the areolar texture of the skin, or into the cellular tissue below the

mucous membrane; and when it is considerable, the part is raised above the surrounding surface, and then gives rise to the variety of ulcer which has been called the *ulcus elevatum*.

This induration has no doubt often been confounded with the infiltration which surrounds the phlegmonoid variety of the suppurating sore, and with that produced by accidental irritation; but in the great majority of cases it may be distinguished by its abrupt termination, and by its equal consistency throughout. Another form of disease, from which it is not so easily distinguished, is the secondary induration, which may form part of the constitutional symptoms of syphilis. This secondary induration may show itself in the same parts as primary infecting sores, and may, like them, be accompanied by induration. In both cases the induration depends upon plastic effusion from a specific cause; in both this has a tendency to assume, more or less, the tubercular form; and in both the induration may terminate abruptly. In general, however, this defined outline is more marked in the primary than in the secondary form of the disease.

It will sometimes happen when there is great induration that the circulation through the part does not readily take place. The surface of the sore may then slough to a certain extent, but this will not prevent the appearance of secondary symptoms (fig. VI.)

Syphilitic infection does not manifest itself immediately upon the application of the poison; a period of *incubation* follows the inoculation, during which nothing is perceived, and the patient thinks himself well. From ten days to seven weeks after the application of the cause, the primary disease will manifest itself. In the interval there may possibly be some other venereal affections, such as arise from the contact of impure secretions, but the characteristic symptoms of the syphilitic infection will not appear until expiration of the period of incubation above named. There is, however, one remarkable exception to this rule, and that is with regard to the re-inoculation of the secretion of an infecting sore soon after its first appearance. At that time the inoculation will succeed much more quickly, and the induration which follows will be sooner developed. It has been said that if a person be inoculated with the vaccine matter on several successive days, the vesicles will all arrive at maturity about the same time. Now, something like this obtains with regard to syphilitic infection. If a person becomes infected, and a sore appears some three or four weeks afterwards, and some of the secretion from that sore be immediately re-inoculated, the inoculation may succeed, and the induration of the two sores will then appear about the same time.

CASE.—A medical student became diseased for the first time in the year 1856. As soon as the sore appeared, and before it had become indurated, he inoculated some of the secretion on his own thigh. I saw him three or four days afterwards. There were then signs of irritation on the inoculated spot. This spot soon became converted into a small, hard, button-shaped sore, and then accurately resembled that from which the inoculated secretion had been taken. A small quantity of white lymph was at first visible in the inoculation, but both sores subsequently remained as small, hard, circular indurations, and furnished scarcely any secretion from their surfaces.

After the characteristic induration has been established, the infecting chancre is no longer capable of being re-inoculated; but for a considerable time, if fresh action be excited in the part, as, for instance, by the application of a blister, a secretion may be obtained which is re-inoculable upon the patient himself (figs. VIII. and IX.) The inoculations thus produced do not resemble in their course the results of inoculations on a patient who has not previously been infected. They have no period of incubation. Their other peculiarities will be described in the chapter on 'Syphilisation.'

Some very remarkable statistics have been produced on the subject of the re-inoculation of the secretion from infecting sores. In 1855, M. Clerc announced the doctrine that this secretion could not be inoculated—a theory which corresponded with, and might have been deduced from, Ricord's dogma, that a person can have syphilis once only. As the indurated sore was said to be the necessary precursor of constitutional syphilis, and as syphilis was supposed always to follow an indurated sore, it followed that, when once the constitutional affection was established, the



Fig 1

Inoculations of secretion from a suppurating sore as they appeared on the 41st day Pilegmonoid variety

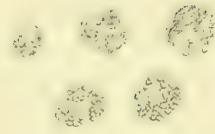


Fig 11

Secretion from local suppurating sore, treated with dilute Acetic acid, and magnified 700 diams.



Fig IV.

Secretion from indurated sore examined in the same way as Fig II.



Fig III

Primary syphilitic inoculation without ulceration



Fig VI

Sloughing of indurated sore. After Cullerier.



Fig V

Indurated sore, not secreting pus not inoculable on the same patient. After Cullerier.

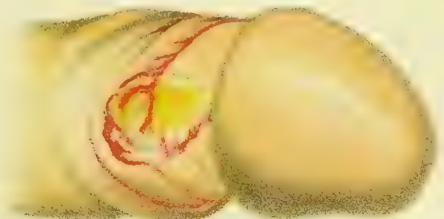


Fig. VII.

Two-fold inoculation suppurating sore re-inoculable on the patient & killed by secondary symptoms.



patient's system in which it was so established would no longer be capable of being re-inoculated so as to produce again the same disease. In 1856, this point was experimentally tested in the Lock Hospital, and the results are recorded in the 'British and Foreign Medico-Chirurgical Review' for the same year. It was then found that the indurated chancre was not capable of being inoculated upon a patient whose system was already syphilitised in the proper acceptation of the term.

In 1856, M. Fournier inoculated a hundred patients from their own infecting sores, and succeeded in his experiments once or twice only. His results were not published until 1858.

M. Rollet, in his recent work, mentions having inoculated two hundred patients who had infecting sores with the secretion of their own chancres. He found that those in whom the inoculation succeeded were six per cent. These sores were said to be *auto-inoculable*. In the remainder the inoculation failed.

Now, Fournier's experiments and Rollet's experience coincide in a wonderful manner with practical statistical details above mentioned. During the years 1855-6 I kept an accurate register¹ of such cases, and out of one hundred that had been diagnosed as suppurating non-infecting sores, secondary symptoms followed, as far as I was able to ascertain, in two instances only. Out of so large a number, the proportion is curiously in accordance with the exceptions in Fournier's and in Rollet's experiments. The exceptions in all three series of observations may be attributed to the same cause—a *twofold* inoculation may in all the instances have taken place, and produced the suppurating local venereal affection as well as the infecting chancre (fig. VII.) The former had probably in Fournier's and in Rollet's exceptional cases furnished the inoculable pus, and had, in my own observations, masked the characters of the affection that I was attempting to diagnose. This conclusion is confirmed by the results of the inoculations as far as the experiments were concerned. The affection produced by the inoculation from the supposed indurated sores was, not an indurated sore of the same nature, but a *pustule*, the characteristic origin of the local suppurating disease. Practically, then, we conclude that if a syphilitic sore yields a secretion capable of being inoculated so as to produce the specific pustule, the evidence, so far as it goes, is in favour of its being a local disease, and not requiring constitutional treatment. If, on the contrary, a disease which we believe to be primary syphilis yields a secretion which is not auto-inoculable, then the evidence is against the local character of the affection, and indicates a constitutional mode of treatment in order to prevent or to mitigate the secondary symptoms.

A few years only have elapsed since the test of a really syphilitic sore, and the propriety of giving mercury for its cure, was supposed to be its auto-inoculability. This doctrine was upheld even in some of our most widely circulated works on the subject of syphilis. But, as now shown, the idea was not only an unsafe guide scientifically, but it was practically the very reverse of the truth. Much confusion necessarily arose; and many of our leading authorities, both here and on the continent, confounded together, and mixed up in their descriptions, the two varieties of venereal disease. These are now, it is hoped, sufficiently clearly distinguished, never again to be confounded.²

In a well-marked infecting sore, the edges are firmly adherent to the subjacent and surrounding tissues. They are smoothly bevelled off, or rounded so that the well-defined sharp edge noticed in the description of the venereal suppurating sore is here wanting. The surface of the infecting sore varies in colour. It sometimes presents a fawn colour; at other times it is uniformly red; at others, again, portions of adhesive matter of a greyish colour will be seen on its surface. These different

¹ Cases regarded as doubtful or mixed were not included in this table.

² The distinction between the two kinds of disease in their mode of *origin* was first recognised in 1854. In my *Pathological and Surgical Observations*, published in that year, the local disease, which commences with a suppurative form of inflammation, is described as a morbid process, distinct and separate from the specific adhesive action which is followed by constitutional symptoms. That the auto-inoculability of a chancre when fully developed was evidence of its non-infecting character was first pointed out by me in the *Brit. and For. Med.-Chir. Rev.* for 1856.

appearances depend upon the accidental circumstance of the separation, or otherwise, of a portion of the plastic exudation which forms the thickened base of the sore.

Besides the nature of the secretion, and the auto-inoculability of that secretion, there is another diagnostic test of very great value in distinguishing primary syphilitic infection, and that is the condition of the corresponding inguinal glands.

In the previous chapter it was shown that some of the material involved in the local venereal sore might be conveyed through the lymphatic vessels, and again reproduce its particular morbid action either in the lymphatic vessels themselves, or in the inguinal glands, and this was regarded as a kind of re-inoculation, or as a translation of the disease by a natural process from one locality to another; and it has been shown in the present chapter that during the early stage of a syphilitic infection the part first contaminated produces a secretion which is also auto-inoculable. These two circumstances will prepare us for understanding the pathology of the chronic indolent enlargement of the glands which constantly attends a syphilitic infection.

The part first inoculated takes on the adhesive form of inflammation. If some of the secretion from this infected spot be inoculated with the point of the lancet before the specific adhesive action develops itself, both inoculated points may become similarly affected; and if by a natural process the same thing be effected—if a portion of the contaminated matter be conveyed along the lymphatic vessels—then at the point where such matter is arrested the specific adhesive action will take place.

Thus both forms of the venereal disease are auto-inoculable—the suppurative form as long as it suppurates freely; the adhesive form during its early stage only, before the specific hardness has appeared. Each form of venereal disease is capable, by natural auto-inoculation (or by lymphatic absorption), of being conveyed to the inguinal glands, and of there reproducing its specific and peculiar action. It would appear, however, that with regard to the suppurating sore in which the discharge is soon thrown off from the surface, lymphatic absorption does not nearly so frequently take place as in the specific adhesive action, where the infected tissue remains often for months as a portion of the living structure of the part. In the suppurating form of the disease, indeed, lymphatic absorption comparatively seldom occurs. It is the exception, and not the rule; and when it does occur, one gland only is usually affected; whereas in the adhesive form of the disease, the inguinal glands are almost always involved, and in general there are several affected at the same time. This has caused the name of *multiple indolent bubo* to be given to this specific affection of the inguinal glands: a condition very surely indicating that the patient's system will be shortly, if it is not already, infected.

The characters of the inguinal glands attacked with specific adhesive inflammation are peculiar. The affection appears at or about the same time as the specific induration at the seat of the primary infection. This peculiar form of auto-inoculation occurs, therefore, at the same period at which the chancre might be inoculated by the lancet upon another part of the same patient's skin.

After an indurated chancre has ceased to be auto-inoculable upon the skin, it probably ceases to furnish any matter to the absorbents which can cause their specific induration. The suppurating venereal sore, on the contrary, which furnishes a secretion which is auto-inoculable until it begins to heal, may also at any period till then give rise to a suppurating bubo.

Sometimes one gland only is involved in a case of syphilitic infection; but generally there are several. Each gland becomes enlarged without causing any pain or inconvenience to the patient, and without his being aware that anything unusual is taking place in the part. The enlargement is confined to the gland structure itself, and does not involve the surrounding cellular tissue. Each tumour may become the size and shape of the dried shell of an almond; and I have been in the habit of describing this peculiar affection as the *amygdaloid* condition of the inguinal glands. Each separate gland may be felt rolling in its bed of loose cellular tissue, and the unaffected skin will move freely over it. These glands are very hard, and give very much the same sensation to the touch as the induration of a primary chancre. The

peculiar hardness depends upon the fact that this newly effused plastic material is confined to the gland, and accurately circumscribed by its capsule.

Lymphatic glands affected with specific induration do not suppurate. When the disease is uncomplicated this may be received as a universal rule. Yet in practice we every now and then hear of buboes suppurating in connection with infecting sores. Some of these are scrofulous buboes; some are buboes arising from some accidental cause of irritation; and some are buboes which occur upon the accession of secondary symptoms, and in consequence of some irritated eruption on those parts of the skin whence the lymphatics which empty themselves into the glands arise.

When all these sources of error in diagnosis have been guarded against, there will still remain a few cases in which an infecting chancre has apparently given rise to a suppurating bubo. The number of such cases has not been ascertained statistically, but they are very few indeed, and probably not even so great in proportion as the cases in which an infecting sore retains its auto-inoculability after the development of its specific induration. The exception in both classes of cases depends, in all probability, upon the same cause—namely, a twofold inoculation upon the same part.

A very remarkable circumstance remains to be noticed with regard to lymphatic absorption, both from the suppurating sore and from the primary infection. The glands into which the absorbent vessels directly enter are those only which are affected. These are called the glands *first in order*. The glands *second in order*—that is, those glands which receive their lymphatic vessels only from other glands—are never affected with the specific action peculiar to any form of venereal disease. It is evident, therefore, that no form of syphilitic action can find access to a patient's system through the lymphatics. The specific action ceases with the first system of glands with which the infected matter is brought in contact, and therefore the affection of the lymphatic glands may be looked upon as a part of the primary symptoms. An inguinal gland affected with specific induration would, no doubt, if no other cause of infection existed, produce constitutional disease; but it would be by means of the blood that circulates through its diseased structure, and not by the passage of the poison into the circulation through the thoracic duct. In the same way a chancre infects a patient's constitution by the morbid action communicated to the blood circulating through its texture, and not by lymphatic absorption.

When once the general system of a patient is affected with syphilis, the same disposition of the effusion of plastic matter as was manifested at the original seat of the disease may occur in any situation. This disposition to plastic effusion may be traced in every stage of the disease. It has been considered in the primary infection, and as giving rise to the peculiar characteristic induration of the lymphatic glands. In the secondary forms of the disease the same action may also be traced in effusion of lymph upon the iris; in the deposit of tubercles in the cellular tissue and in various internal organs; in nodes upon the bones; and in various kinds of papular and tubercular eruptions upon the skin. All these different forms of secondary disease may be referred to the same tendency to plastic effusion; the effused material, if allowed to remain, being influenced by, and becoming part of, the structure in which it occurs.

In the treatment of syphilitic infection, after the disease has manifested itself, cauterisation is of no avail, as far as the prevention of constitutional symptoms is concerned. The period of incubation which has already elapsed forbids the idea that the poison can then be destroyed by the application of caustic to any particular part. Practically the same truth is found unfortunately to be but too evident. Infecting sores, that have been destroyed on the very day of their appearance, have subsequently continued to spread, and have produced their natural consequence. Even if an infecting sore be cut out, the infection of the patient's system will not thereby be prevented. The diseased action has already spread to other parts, and has already perhaps commenced in the lymphatic glands before any visible indication of its existence presents itself. A sustained, judicious, and constitutional mode of treatment is the only one that can be relied upon in the treatment of this disease.

CHAPTER IV.

LYMPHATIC ABSORPTION.

PHYSIOLOGISTS have usually recognised three modes by which absorption may take place : —

1. That by which foreign substances find their way directly into the blood through the coats of the blood-vessels.

2. The absorption of the chyle from the mucous surface of the intestines by the lacteals.

3. Absorption by the lymphatics.

To these three modes of absorption, by all of which extraneous substances have been supposed to produce their effects upon a patient's constitution, we may add a fourth means by which the system may be influenced by the action of some kinds of poisons ; namely, that in which a direct local effect is produced upon the nerves of a part, and through them upon the brain (and consequently upon other organs), without the poisonous material being taken into the blood.

Examples of this mode of the action of poisons are afforded by the effects of the juice of the leaves of the aconite, and of the infusion of tobacco, as illustrated in some of Sir B. Brodie's physiological experiments.

In most instances the action of a poison commences immediately upon its application. But in the case of morbid poisons, a certain interval must elapse, and a certain morbid process must be gone through, before these can produce their specific actions upon the general system.

The deleterious materials of which these poisons essentially consist, or the secretions in which they are contained, may be applied to the living body in any quantity, and for any length of time ; and unless the process, which is peculiar to each of them respectively, be gone through, its characteristic effects will not as a rule be produced upon a patient's constitution.

If the particular action by which these poisons individually enter the system be disturbed or interfered with—so as not to be carried out—other results may follow, but their full general and specific influence will not be experienced. If the first step in the process be defective, so will be its natural consequences.

The knowledge which we thus obtain furnishes us with a most important power ; for, by modifying or altering the morbid process by which a poison enters the system, as, for instance, by the early application of caustic to the infected part, we may, under certain circumstances, modify or control its effects.

I purpose now to consider how far the action of the syphilitic poison upon the constitution may be thus modified or controlled, by the kind of action which is produced when it is first applied to the living tissues of the body. For this purpose it is requisite to consider what the morbid actions really are by which the syphilitic poison gains an entrance ; and what the natural processes are by which it joins itself to, and becomes as it were incorporated with, the living being.

The opinions of Hunter on the absorption of the syphilitic poison have given a bias to all subsequent reasonings upon the subject ; and the theories based upon his experiments are very generally received even up to the present time. He demonstrated, as he believed, that the lymphatic vessels were the true absorbents ; and he concluded from his discovery that they were the *only* absorbents in the system.

The experiments upon which his idea was founded deserve attention. Assisted by his brother and several other eminent medical men, he confined some warm milk in a portion of small intestine ; and having tied the artery and vein which supplied the intestine, he saw, as he believed, the lacteals of the part presently become filled with the white milk. Upon puncturing the vein upon the distal side of the ligature, it was soon (by pressure of the finger) emptied of its blood. No white fluid could, during the continuance of the operation, be found in the vein. Upon a repetition of

the experiment, in which the circulation through the mesenteric vessels was left free, the blood in the vein was carefully examined and compared with that in the neighbouring veins, but it was found not to be light-coloured, nor milky, nor could any difference whatever be detected in it. It was found that even by firm pressure, which was continued until the intestine burst, the milky fluid could not be made to pass into the veins.

In another animal, some thin starch, coloured with indigo, was introduced into the small intestine, and the lacteals were soon afterwards seen of a fine blue colour. A vein in this part of the mesentery was opened, and the blood which flowed was allowed to separate into coagulum and serum. The next day the serum had not the least bluish cast.

An injecting pipe was then fixed in an artery of the mesentery, where the intestine was filled with blue starch, and all communications both in the mesentery and intestine were closed, with the exception of the vein corresponding with the artery. Warm milk was now injected until it returned by the vein. This was continued until all the blood was washed away, and the vein returned a bright white milk. The milk thus circulating through the intestine containing the blue starch was not in any degree changed in colour.

In a third animal, some musk in warm water was confined in a portion of the intestine; after waiting a little time, some of the lacteals of the part were opened with a lancet, and some of the watery fluid which they contained was received into a small spoon. This was thought to smell strongly of musk. Some blood received into a clean spoon from one of the veins of the same part had not the least smell of musk.

From these and similar experiments, Hunter arrived at the inference, which must have appeared one of the greatest discoveries of his age, *that the veins do not absorb in the human body*. It necessarily followed from this that the lymphatics were to be considered as the only absorbents; and this is stated by Hunter to be the fact, in his work on the venereal disease.

If the lymphatics were the only absorbents, they must of necessity have been looked upon as the only channels through which poisons could, under ordinary circumstances, enter the system; and accordingly we find Hunter asserting that the venereal matter is taken up by the absorbents of the part in which it is placed, and carried along the absorbent vessels to the common circulation.

This view, deriving as it does such an apparent confirmation from the frequent occurrence of inflammation of the lymphatic glands in venereal diseases, was adopted with more or less modification by almost all the writers on syphilis who followed Hunter.

The accuracy of the experiments upon which Hunter based his theory has, however, justly been doubted by other physiologists; but the theory itself, as regards the syphilitic poison, was up to a recent date, strange to say, scarcely questioned.

MM. Tiedemann and Gmelin, after mixing various substances, which might easily be detected, with the food of animals, not unfrequently found unequivocal traces of these substances in the venous blood and urine, whilst it was only in a very few instances that traces of them could be discovered in the chyle.

In repeating Hunter's experiments, Mayo found that half an hour after a solution of starch and indigo had been placed in the cavity of the intestine, the lacteals appeared of a clear blue colour; and those present were for a time satisfied that the indigo had been absorbed. But upon placing a sheet of white paper behind the mesentery, it was found that the blue tinge had disappeared. On removing the white paper, the vessels re-assumed their blue colour. It became, therefore, evident that the blue tinge was the natural colour of the empty lacteals; that while they continued to absorb the chyle they were white, but that as soon as they were simply empty they appeared blue.

Thus a repetition of the Hunterian experiments rather tends to prove that the function of the lacteals is limited to the absorption of chyle; and that the lymphatics are not the only absorbents appears most conclusively demonstrated by the

experiments of MM. Magendie and Ségalas. M. Ségalas varied Hunter's experiment in the following manner: A fold of small intestine was drawn out of a wound in the belly of a dog; all the blood-vessels passing to and from it were tied, with the exception of one artery; a vein punctured upon the mesentery allowed the blood to escape, which would otherwise have stagnated in the part. The lacteal vessels and nerves were left entire. The fold of intestine was then tied at both extremities, and an aqueous solution of the alcoholic extract of *nux vomica* was poured into it. During the hour which followed, the poison produced no symptoms. The ligatures being then removed from one of the veins, the blood was allowed to return in the natural course of its circulation. In six minutes from this time the poison took effect.

The experiments of M. Magendie illustrating the same point are well known.

The thigh of a dog was separated by M. Magendie from the body, by a division of every part, with the exception of the artery and vein; into each of these vessels a quill was introduced and tied by two ligatures; between these ligatures the vessels were divided, and thus all communication was cut off between the body and the limb, except that which was maintained by the circulation of the blood. Two grains of the *upas tiénté* were then inserted into a wound in the foot of the separated limb. In about four minutes the poison manifested its effects upon the system.

From these and other facts, it appears certain that Hunter's idea of the lymphatics being the only absorbents is incorrect; and we are thence naturally led to the consideration of the value of the theory of the mode of absorption of the syphilitic poison which was based upon that notion.

When lymphatic absorption takes place in connection with a suppurating venereal sore, the action of the poison may be traced in the clearest way along the absorbent vessels. In any part of its course, the poison may inoculate the vessel in which it is contained, and may produce a fresh venereal sore, the secretion of which may again be inoculated. It usually happens, however, that the inguinal gland in which the absorbent vessels terminate is the part affected. Here alone, in the great majority of cases, does the poison exercise its influence upon the absorbent system; but that the poison actually passes, as such, through the absorbent vessels we have abundant proof in the specific effects of the poison in the course of those vessels. Between the lymphatic gland and the primary disease, a small abscess will occasionally form. This will present tumid and irritable edges, will afford all the characteristics of a suppurating venereal sore, and will furnish an inoculable secretion. We can then distinctly trace the entrance of the venereal poison into the lymphatic vessels, and from them into the absorbent glands in which these vessels terminate. The actual existence of the virus in any part of this course may be demonstrated by experiments, which have been far too often repeated to require any additional confirmation. Arrived at this point of its course, on its way apparently towards the thoracic duct, and from thence to the general circulation, what becomes of it? A very wonderful change is here brought about. The specific virulent poison, which before was liable to contaminate every living part that it came in contact with, cannot be traced beyond this point. The absorbent vessels between the inflamed gland and the thoracic duct do not ulcerate or suppurate; the glands into which they empty themselves do not become enlarged or inflamed. The influence of the poison is here then gone. Beyond the glands first in order, the fluids which the absorbent vessels contain are bland and harmless, incapable of being inoculated, or of infecting any part with which they come in contact. What then has become of the poison? We find it in the vessels going into the inflamed absorbent glands, but we do not find it in the vessels which proceed from those glands. In a certain number of cases, no doubt, the poison is in great measure discharged in the suppuration to which its presence gives rise. But, when we consider the exceedingly minute quantity of an animal poison that is capable of producing its specific action on a part, this explanation is not sufficient. Some of the fluid or particles which enter the gland must, in some form or other, we should think, pass through it, whether it suppurate or not. Even although we should suppose that the inflammation produced in the gland entirely obstructed its channels, still, before such obstruction could take place, some

fluid would surely have time to pass; and this, if its quality remained unchanged, would be sufficient to inoculate any part with which it came in contact, or to infect the general system.

A similar series of phenomena may be observed in the affections of the lymphatic vessels which accompany an indurated primary syphilitic sore, with the exception that the action in the glands is of the same nature as that which constitutes the primary disease. The poison taken up by the lymphatics may during the earliest stage of the disease inoculate a lymphatic vessel; and it almost always inoculates one or more of the lymphatic glands, so as to produce in them exactly the same kind of disease as existed in the part from whence the morbid material was derived. But beyond the lymphatic glands first in order, no farther effect is produced upon the lymphatic vessels. The fluids which they contain are bland and harmless, and afford no indication of containing any poisonous or irritating ingredients.

Up to this point, then, we have unequivocal evidence of the presence of the venereal poison, and of its power of contaminating fresh parts. Beyond this, the poison can no longer be traced. The fluids in which it was before contained now neither possess the power of irritating the vessels through which they pass, nor, when extravasated from these vessels, of infecting other structures. Here, then, some wonderful change is produced. The specific characters of the poison can no longer be detected either by its morbid effects or by inoculation. Even Hunter noticed this circumstance. He says, 'We never find the lymphatic vessels or glands that are second in order affected.' And he remarks that, when the disease has been contracted from a cut upon the finger, he has seen the bubo come on a little above the bend of the arm, upon the inside of the biceps muscle. In such instances no bubo has formed in the arm-pit, the most common place for glands to be affected by absorption.

Virchow has noticed the same point. In speaking of the occasional introduction—or intravasation, as he terms it—of pus and other diseased products into venous and lymphatic vessels opened by abscesses and ulcers, he remarks that the transit of pus by lymphatic vessels is not at all uncommon, but he contends strongly against the production of general pyæmic infection by this means. 'All the lymphatic vessels,' he says, 'which are in a condition to take up pus in this way are peripheral ones, whether they arise from external or internal parts, and only after a somewhat lengthened course do they gradually reach the blood-vessels. In all, interruptions are formed by the lymphatic glands; and since we know that the lymphatic vessels do not pass through the glands as wide, tortuous, and interlacing canals, but that, after they have broken up into fine branches, they enter into spaces which are filled with cellular elements, it is manifest that no pus-corpuscles can pass a gland.' This very important point of view, although it meets with the best possible confirmation in the daily experience of the practical physician, is generally overlooked, as Virchow conceives. He instances the process of tattooing. However minute the subdivision may be of the substances introduced, we never find these conveyed beyond the nearest lymphatic gland. In proof of this statement, Virchow adduced an example in which substances, introduced for this purpose by a soldier fifty years before, had not penetrated farther than the nearest lymphatic gland, as proved by microscopical examination of the parts.

Although, as he remarks, these glands act as a filter, in mechanically retaining the coarser particles contained in the current of fluid passing through the glands, that is not by any means their whole office. 'They have manifestly another part to play, inasmuch as the substance of the glands indubitably takes up into itself certain ingredients from the fluid mass of the lymph, retains them, and thereby also alters the chemical constitution of the fluid, so that it quits the gland all the more altered, because it must at the same time be assumed that the glands yield up certain constituents to the lymph, which did not previously exist in it.' Virchow illustrates these statements by an appeal to ordinary phenomena observed in cases of malignant tumour and syphilis. 'When an axillary gland becomes cancerous after previous cancerous disease of the mamma, and when, during a long period, only the axillary gland remains diseased, without the group of glands next in succession or any other organs becoming affected with cancer, we can account for this upon no other supposition than that the gland collects the

hurtful materials absorbed from the breast, and thereby for a time affords protection to the body ; but at length this protection proves insufficient ; and perhaps at a later period the gland itself becomes a new source of independent infection to the body, and a further propagation of the poisonous matter may take place from its diseased parts.'

Neither observation nor experiment, then, affords any proof that the venereal virus is conveyed, as such, through the absorbent glands ; all the direct evidence which we have points to an opposite conclusion. The particles in which the poison resides here undergo some change, become perhaps disintegrated, and after that process the effects of the poison in the lymphatic vessels appear to cease.

The evidence upon which it has been assumed that the venereal poison enters the system through the absorbent vessels must, therefore, be regarded as most inconclusive. Arrived at the first lymphatic gland which it meets, and there undergoing some change, it becomes incapable any longer of producing its specific effects ; and we cannot therefore admit that this is the way in which the system becomes infected after the specific primary adhesive action.

If we reflect upon the different ways in which foreign substances can be taken into the living body, we shall find that every such way is furnished with certain sentinels or guards, which oppose the entrance of materials which, if admitted, would prove injurious. Whenever any irritating matters are applied to the skin, which might, by being absorbed, become injurious to the system, the delicate sense of touch informs us of what is going on, and urges us to get rid of the offending material. This is a sense common to the whole body. But the parts through which foreign matters are usually taken into the system are guarded in an especial manner. Thus, in addition to the sense of touch, we see the mouth guarded by the sense of smell and that of taste : three out of five senses concentrated around the opening by which the food enters into the system ; and one at least of the other two always ready to assist in affording information of its nature. If we trace the food onward, we find that it has to pass the double row of teeth, which are acutely sensible to the presence of any hard particles that may have become accidentally mixed with it. Should any fresh flavour be produced in the process of mastication, there are the means provided for appreciating it as the food passes through the posterior fauces. The stomach we find ready, in its turn, to reject that which is injurious ; and throughout the alimentary canal there is an apparatus composed of a multitude of different parts, all combining to hurry on and eliminate from the system any materials which, if left, would be detrimental to it.

Finally, we have a wonderful system of minute capillary tubes (endowed with the faculty of distinguishing, so to speak, the chyle from other matters) taking up and pouring freely into the blood that which is required for the nourishment of the system, but refusing to admit anything else. These lacteals are very similar indeed in structure, in disposition, and in function, to the absorbent vessels elsewhere. It is true that we cannot trace equally well the processes involved in the assimilation and absorption of the different individual organs of the body, as in the analogous actions which convert the food originally into part of the living being ; but, from what we do know, we have abundant evidence that the same care is taken with regard to each part as with respect to the whole ; and we have reason to believe that other channels, through which foreign matters may enter the system, are guarded with the same care as that by which the common food is received.

Such facts would lead us to the *à priori* conclusion that some means must exist to prevent the indiscriminate introduction into the circulation of any materials which might find their way into the absorbents during the active ulceration of a part ; and observation demonstrates to us that such a provision really exists. The particles taken up by absorption ultimately again form part of the general circulating fluid from which they were at first derived. They have as much to be assimilated as animal matter taken fresh into the stomach. The bone, the tendon, the muscles, the nerve, which are thus removed, can no longer be recognised as such after they have been acted upon by the absorbents. All the different tissues that undergo this process form a single fluid, which ultimately becomes a part of the general circulating mass,

and can then in no way be distinguished from similar products derived from the process of ordinary digestion. The action which converts foreign animal matter into blood, and that which converts parts of the living body into blood by the agency of the absorbents, are then analogous; and they agree in having the very remarkable property of converting some substances, which when introduced in any other way act as poisons upon the system, into harmless agents. It has been shown by the Abbé Fontana, that the poison of the viper, when introduced into the stomach, undergoes some change which prevents its poisonous effects upon the system. It has also been shown by two French physiologists that the same thing happens with regard to the woorara poison, and we have it upon no less authority than that of Sir B. Brodie that opium may be digested in the stomachs of some animals, and that in that process its poisonous qualities are destroyed. 'I have injected,' says Sir B. Brodie, 'a strong watery solution of opium into the stomach of a rabbit, but no poisonous effect was produced, although a similar solution, injected into the cellular membrane, occasions stupefaction and death.' In like manner, we find that cancerous matter cannot be propagated from a part to the general system through the lymphatic glands; but we have evidence to prove that it may, under certain circumstances, be so propagated through the blood-vessels. It is true that the veins in the immediate neighbourhood of a cancer are very frequently blocked up with coagula, affording another instance of the preservative power above mentioned; but when this is not the case, the cancer cells may apparently be conveyed in the course of the circulation and infect distant parts. We have an experiment on the authority of Langenbeck, related in the 'Encyclopédie anatomique,' in which some fresh cancerous matter was injected into the veins of a dog, and cancerous tubercles were consequently developed in the animal's lungs.

In like manner, I suppose, it might be possible under certain peculiar circumstances to infect the general system with cancer through the absorbent vessels; but the fact that the glands first in order only are affected in consequence of local cancerous diseases, forbids the idea that this is the way in which the disease is usually conveyed to other parts.

These observations will enable us to consider on sound physiological principles the change that is produced in the venereal poison during the passage of the matters in which it is contained through the lymphatic glands. These materials are themselves undergoing a change which will fit them for becoming part of the circulating fluid, and it would seem that the poison also undergoes a change similar to that produced in the poison of the viper, or in the woorara poison, by the stomach.

The difference in the nature of the fluid in the lymphatic vessels, before and after it has passed the inguinal glands, is then analogous to the difference in the qualities of the woorara poison before and after it has undergone digestion in the stomach and the lacteals. In both cases do the fluid contents of the lymphatic vessels undergo a change fitting them to become a part of the circulating fluid; in both cases are poisonous matters sometimes converted or assimilated, and sometimes rejected; by vomiting in the case of the stomach, by suppuration in the case of the lymphatics.

In looking over my notes of cases which presented themselves at the Lock Hospital during the year 1854, I collected together and arranged in a tabular form forty-nine consecutive cases of suppurating bubo. Of these, five only are recorded as having been accompanied, or followed, by any secondary affection during the period that they remained under observation. In one of these five there was a distinct history of previous disease, both primary and secondary. In another, the cervical glands were enlarged, and the suppuration in the groin may therefore probably have been of a strumous character. In two cases, the secondary eruption was tubercular—an affection most obstinate in its nature, very liable to recur after having once disappeared, and comparatively seldom occurring as the first symptom of cutaneous disease. These, then, I regard in all probability, like the first of the five cases, as the result of some previous syphilitic infection. This analysis would thus leave only one case out of forty-nine in which a disease which produced a suppurating bubo also produced secondary syphilis.

On the other hand, I collected and tabulated in the same way thirty-one consecutive cases of secondary syphilitic eruption. In one only of these cases does the history afford any mention of a suppurating bubo, and in that one case the history is not satisfactory upon the point. Such facts appear to establish indisputably the proposition that the chances of the infection of the system in cases of syphilis are inversely in proportion to the degree of irritation and inflammation of the absorbent vessels leading from the primary seat of disease.

Physiological absorption.—Hunter believed that the syphilitic poison might be simply absorbed by the vessels of a part, without giving rise to any local affection; and ever since his time there have been original observers who have held the same doctrine. Thus Mr. Lane, one of the present consulting surgeons of the Lock Hospital, has shown, by inoculation, that a bubo was of a specific character, when no primary lesion could be found upon the most minute examination; Dr. Marston, of the Royal Artillery, has lately recorded cases in the ‘Transactions of the Royal Medical and Chirurgical Society,’ in which constitutional syphilis occurred without any previous primary symptom. And cases have occurred in my own practice in which every effort has been made to discover a primary lesion in cases of constitutional syphilis without any such being detected.

Lymphatic absorption in the female.—Although buboes are not so generally observed in women as in men, yet when they do occur in connection with venereal sores on the external parts of the organs of generation, they are equally characteristic of the nature of the affection. A suppurating venereal sore which has been subjected to irritation in a woman will sometimes produce the characteristic suppurating inguinal gland, and an indurated sore on the skin will be followed by the corresponding affection of the glands previously described as *amygdaloid*. It frequently, however, happens that a woman who has never been pregnant will be found to be syphilitic without any enlargement of the inguinal glands. The distribution of the lymphatics affords a satisfactory explanation of this circumstance. The lymphatics from the skin, the vestibulum, and the mucous membrane of the clitoris empty themselves into the inguinal glands, but those from the vagina proper and neck of the uterus communicate directly with the glands within the pelvis.

It sometimes happens that women suffering from some affection of the vagina or neck of the uterus are attacked with very severe and persistent pain in the iliac region on one side. The pain, as the author has witnessed, is occasionally of the severest character, and may last for days. There is no corresponding febrile disturbance in these cases, no heat of skin nor hypersensibility in any other part. Such cases may have been mistaken for inflammation of the ovary, or for peritonitis, such as has been described as the consequence of gonorrhœa extending up the Fallopian tube, but it appears to be much more probable that the symptoms depend upon an enlarged or inflamed lymphatic gland within the abdomen.

Cruikshank¹ observes that when a chancre is formed on the glans penis, there is seldom a bubo in the groin, and yet that the constitution may be affected by the disease as certainly as when it occurs upon the pressure.

The superficial lymphatics of the glans penis have been demonstrated to communicate with vessels going to the inguinal glands in the groin; the lymphatics from the substance² of the glans probably join those which run along the urethra into the pelvis. In like manner, the superficial absorbents of the clitoris go to the inguinal glands, but the deeper probably pass directly into the abdomen. Although Cruikshank’s observation can hardly be maintained with reference to absorption by the superficial lymphatics, yet his idea appears to be well founded with regard to cases where these may have been destroyed, and absorption may have taken place only from the deeper structures. Practically we may conclude that as non-specific affections of the uterus and upper parts of the vagina do not produce enlargement of the inguinal glands, neither do venereal affections which are confined to these parts. The proportion of venereal cases in which the enlarged glands can be detected is therefore less in women than in men.

¹ *On the Lymphatics*, p. 152. ² The Author is not aware that these have been dissected.

CHAPTER V.

DESTRUCTIVE SYPHILITIC INFLAMMATION : PHAGEDÆNA : SERPIGINOUS SORES.

DESTRUCTIVE SYPHILITIC INFLAMMATION.

It is a very remarkable fact that some of the most vascular parts of the body, and those the best supplied with nerves, are, under certain circumstances, the most prone to mortification. The parts of generation, amply supplied with nerves and blood-vessels, will, under the influence of the venereal poison, occasionally become intensely inflamed, and that inflammation will speedily terminate in gangrene. If the gangrene so produced occurs within a short time after the application of the poison, the death of the part involves the destruction of the poison. They together cease to exist; and, when the slough separates, an ordinary sore alone remains, requiring no specific treatment.

Mortification of some part of the organs of generation sometimes appears to depend upon a diseased state of the blood, independent of any local cause. The blood will stagnate in the capillaries of the skin here as elsewhere; and the tendency to mortification will first show itself in the most vascular parts. The skin will be affected before the areolar tissue, and the areolar tissue before the fibrous and membranous parts.

1. The mortification, which involves the whole of the infected tissues, will sometimes be of the dry kind, but generally it will be of the moist variety. In the first there will be little pain or swelling, but in the second there will be much effusion, with great pain and a considerable amount of constitutional disturbance. Both these varieties of mortification may occur where there is no evidence of the disease having arisen from the application of any poison; and, on the other hand, they will occasionally as evidently appear to depend upon direct contagion. Patients in apparent health will sometimes, within three or four days after exposure, find some part of the organs red, swollen, and extremely painful. In the centre of the inflamed part a dusky spot will indicate that the blood has already begun to stagnate in the vessels. The nutrition of the parts is no longer maintained; irregular excavations are made by small portions of the tissues being thrown off in the sanious discharge. The whole part affected becomes of a darker hue, and ultimately presents the ordinary appearance of gangrene. After a time a line of demarcation is established, the slough is thrown off, and the wound generally cicatrises without difficulty. This process, effected by nature, is very similar to that which is artificially produced by the application of caustic to a suppurating venereal sore. In both cases, if the mortification has reached all the parts which have imbibed the poison, the destruction of the poison will take place in that of the tissues which contained it.

In cases where the whole of the infected tissues perishes, there is very seldom indeed any subsequent affection of the patient's system, even supposing he has been in a position to contract an infecting sore; and the reason of this doubtless is, that the action which terminates in mortification commences at the same time as or very soon after the application of the poison. In cases where the mortification has been artificially produced, on the contrary, a period of incubation may have existed, of some days or weeks, before the disease has shown itself, and consequently before the caustic is applied; and during this time the tissues will have imbibed the poison to a greater extent than the caustic can reach.

The morbid action, which we are now considering, appears to be communicable by contact, although this cannot be so closely traced as in the other forms of venereal inoculation. In patients, for instance, in whom the general health has not been impaired, parts which have no direct connection, either by blood-vessels or nerves, will appear to infect each other. Thus the glans and the prepuce, the opposed surfaces of the labia or of the nates, will sometimes become affected in a similar manner and exactly to the same extent; and when lymphatic absorption accompanies

the gangrenous inflammation, the destructive action is tolerably sure to be communicated from the original sore to the corresponding inguinal gland, and from it to the surrounding areolar tissue and skin.

2. The second form of destructive inflammation is by far more common, and ordinarily of much longer duration. In it the infected tissue dies slowly, bit by bit, by a kind of molecular necrosis; and, in consequence of this tardy action, the whole of the infecting portions never perish at the same time. A part is always left as a focus of contagion, and this involves fresh portions, which, in their turn, are thrown off, but not before they have communicated the disease to parts beyond.

This action constitutes the *phagedænic* venereal sore. It may appear as an original disease, or it may supervene upon any of the forms already described. It is inoculable, and generally arises from the direct result of the application of the venereal poison; but secondary forms of syphilitic disease may assume precisely the same characters. These, however, cannot readily be inoculated upon the patient, whereas the primary phagedænic ulcer can.¹

The phagedænic ulcer spreads irregularly in different directions, is accompanied often by much pain, and yields a profuse discharge. This consists of an ill-formed sanious pus, mixed up with the débris of organic tissues. It does not affect the inguinal glands, provided these have not become implicated before the phagedænic action has fairly set in; if they have, the bubo will probably open and present the same phagedænic appearance as the original sore.

There is one form of the destructive syphilitic inflammation which presents very peculiar characters. Instead of spreading from one point in a more or less circular form, the disease may slowly extend in the form of portions of circles, from several points at once; or, while the central portion first attacked heals, the affection will spread in a circular form, continually attacking fresh parts. The skin which is healed will then present a shining glazed appearance, surrounded by a dark-coloured circle of irregular so-called ulceration. This affection has been named the *serpiginous chancre*. Like every other form of chancre, it may be accurately simulated by a form of secondary disease, the capability of ready inoculation upon the patient who has it alone as a rule excepted. This affection spreads by a true necrosis: as one part heals, another becomes in succession red, livid, and disintegrated, the particles being thrown off in a thin sanious discharge. The loss of substance is occasioned entirely in this way, and not at all by the action of the absorbents. This form of destructive inflammation will sometimes continue for months, or even years; occasionally nearly healing, and then again, without any apparent cause, spreading in the same peculiar manner. It affects the folds of the groin, and the inside of the thighs and nates, perhaps more frequently than any other parts.

The destructive inflammation that occurs on the surface of an indurated chancre will sometimes present the same appearance for a short time as a soft phagedænic sore. This must be regarded as an accidental complication only, and not as a variety of the true phagedænic ulceration (fig. VI.)

A patient had a most obstinate serpiginous sore which defied all treatment. He was inoculated with different kinds of syphilitic matter. Nothing remarkable occurred from these inoculations: he was then inoculated with the secretions from his own serpiginous sores. The results of these inoculations were the production of sores exactly similar in character to those from whence the secretion was taken.

Upon each inoculated point a very well-developed and fully formed pustule appeared within the first few days. These pustules were depressed in their centres, and when they broke left exceedingly irritable ulcers. These ulcers were extremely painful, and surrounded by a deep red margin. A series of three sets of inoculations was performed, and the poison appeared quite as active and virulent at last as at first.

¹ The experiment of inoculating this form of disease should be carefully avoided; for a surgeon can never tell when the artificial inoculation which he produces will heal, and he will have the credit of having prolonged the disease if the original sore should heal before the inoculation.

CHAPTER VI.

LOCAL TREATMENT OF VENEREAL SORES.

Treatment of suppurating venereal sores.—The venereal poison requires a living nidus for its development, and a certain period must elapse before its specific action can take place. If within the first five days of the application of the poison the part to which it is applied be destroyed by caustic, the death of that part will determine the cessation of the morbid action. This cauterisation, to be effective, must, however, extend to all the tissues which have imbibed the poison. It can, therefore, only be practised with success in the case of those chancres which appear within a very few days of the application of the poison. If a period of incubation have taken place, the tissues will so have imbibed the poison, that it will be in vain to attempt to destroy all the parts that have been infected.

Suppurating sores generally make their appearance very shortly after the application of the poison; and to these, therefore, the method of treatment by cauterisation is admirably adapted. For the purpose of securing the intended result, strong caustics should be used; and as these may sometimes extend further than is desired, it is always advisable, before applying the caustic, to have an antidote at hand, so as to limit its action when necessary. When the caustic has produced its requisite action, the antidote may be applied; this will have the effect of preventing the destruction of more tissue than is necessary, and also relieve the pain to which it gives rise. Thus, if a strong acid be used, a solution of carbonate of potash, or chalk, will form a good antidote. If an alkaline caustic be employed, some vinegar may very conveniently be used to limit its action. When nitrate of silver is applied, the common olive oil is the best subsequent application.

The caustics most used for the purpose of destroying the suppurating syphilitic sores are the mineral acids, or a combination of potash and lime. The nitrate of silver will seldom extend sufficiently deep to eradicate the disease.

The strong nitric acid has often been employed, and acts extremely well; but it gives very considerable pain when applied to the surface of the body.

Another preparation which has been very much used is a combination of sulphuric acid and powdered vegetable charcoal. According to M. Ricord, when this preparation, in the form of a paste, is applied to a chancre, it dries quickly, and forms a kind of black crust, which remains adherent to the tissues, combines with them, and is not detached for several days. The wound will then be found in a suitable case to have lost its specific qualities and to be in a healing condition. The application of this caustic causes very severe pain, which lasts for a considerable period. The pain, however, is said to be less than that produced by the nitric acid; but then it does not admit of being relieved in the same way by the application of an antidote.

Perhaps the most convenient form of caustic is the potassa cum calce, as prepared in the shape of little rods for the purpose. The lime combines with the moisture of the parts, and prevents this from extending itself over the neighbouring surface. The extent to which this caustic acts may therefore be regulated in the most accurate manner; and after it has done its duty, the application of some dilute acid will relieve the pain which it has caused.

The actual cautery is a remedy which has often been successfully used for the phagedænic form of ulceration. The object with this, as with the other kinds of caustic, is to destroy the whole of the infected tissue, and *completely* to kill every part to which the cauterising action extends. For this purpose the cautery should be heated to a white heat, and allowed to remain on the diseased part sufficiently long to destroy the tissues to the requisite depth. Phagedænic sores treated in this way have been known subsequently to present a healthy surface, and to heal without further trouble.

Serpiginous sores are often too extensive to be conveniently treated in this way. A modification of the plan may then be adopted. The outer edge of the sore may be alone destroyed, so that the diseased part may be completely surrounded by an

artificial line of demarcation. This will sometimes prevent the extension of the disease. It will often happen that the edges of serpiginous sores are undermined, and if the cautery be then applied to the edges only of the skin, it may not reach to the circumference of the disease. It is safe, under such circumstances, to destroy the skin deeply two or three lines from its detached margin.

The ordinary suppurating venereal sore, if not in its origin destroyed by caustic, will generally run its course, of five or six weeks' duration, and heal of its own accord, without leaving any injurious effects in the patient's general system.

It may be well, however, to use various means to accelerate the healing of a suppurating sore, and such means are sometimes absolutely necessary.

So long as the sore has the specific characters of ulcerating deeply, with clearly defined vertical edges, it is well to continue the use of some mild caustic, such as a solution of nitrate of silver. When granulations spring up and the base appears healthy, it matters little what applications be used, provided the part be kept scrupulously clean.

The ulcer may assume the characters and appearances of similar lesions elsewhere situated—*e.g.* it may be indolent, irritable, or inflamed, or, by granulating too redundantly, impede the cicatrisation. Such symptoms are to be met by the same measures as would ordinarily be used.

If the chancres threaten to slough, it is best to dry the parts and apply nitric acid; afterwards using a lotion of potassio-tartrate of iron.

With a solution of that salt applied to the sore, and the administration of the same drug internally, the phagedænic action will almost always alter its character. Some intractable or phagedænic ulcerations are best treated by a mixture of one part of strong nitric acid to two, three, or four parts of distilled water; at other times a solution of carbolic acid, one part in forty, answers very well.

The common red wash of St. George's Hospital is an admirable dressing for phagedænic sores. It contains sulphate of copper, camphor, and Armenian bole. The last-mentioned substance prevents the lotion drying on the part.

In cases that threaten to spread, five or ten grains of the sulphate of copper may be used to an ounce of distilled water; but as this is likely to cause considerable pain, it is well to combine with it an equal quantity of opium, either in the form of powder or extract.

Solutions of sulphate of zinc or nitrate of silver (two grains to the ounce) are also often used.

When the acute form of destructive inflammation occurs soon after exposure to contagion, it must be remembered that the action which is taking place *may* save the patient's constitution from syphilitic infection. It would therefore not always be advisable to prevent that action entirely, even if we had the power of so doing; the object of treatment is to restrain it within due limits. For this purpose fomentations and poultices are generally sufficient as local applications. Leeches in considerable numbers have been recommended, but the ultimate benefit derived from them is doubtful: large and repeated doses of opium with an occasional brisk aperient furnish the best mode of constitutional treatment.

Of the buboes which attend and accompany suppurating chancres, two varieties may be mentioned. The progress of the first we can hope to arrest, while that of the latter will surely go on.

First. An inflammation of the lymphatics, such as often occurs after abrasions or wounds of other parts, may arise. The nearest inguinal gland may enlarge, and the textures around it may inflame, without there being any specific material in the gland-tissue itself. If an abscess form, it is a simple abscess, and the ulcerated surface does not become a chancre, affording inoculable discharge.

Second. When venereal lymphatic absorption occurs from a suppurating sore, there is a transmission and lodgment of a chancreous virus, in a gland or in a lymphatic vessel. An abscess will then ensue, and the resulting ulcer will oftentimes be but a repetition of the chancreous process, and is to be treated, therefore, in a similar manner as the original chancre.

When we have no means of deciding to which division the symptoms in the lymphatics are to be referred, it is well to try—by a few leeches, perfect rest, hot or cold applications, pressure, and the applications of vesicants—to prevent suppuration. Of the latter, the best are—the vesicant action by a strong solution of iodine, or painting the integument with a strong solution of nitrate of silver, dissolved with the aid of a little nitric acid, as suggested by Sir Henry Thompson. As soon as the effect of these remedies has subsided, pressure may be employed if the parts are still enlarged.

Should these plans fail, it is better to allow the patient to get up and walk about in the air.

Suppuration having set in, shall we open by multiple and small incisions, or by a depending one, involving the whole length of swelling? The former course—with or without the use of stimulating injections—has proved very uncertain in its results; a free opening is generally to be preferred. The wound may then be dressed with strips of lint, from the bottom.

If the integument be thin and undermined, the action indolent, and the skin of a dull red colour, opening from the abscess, by means of a liberal application of potassa fusa, will be found to expedite considerably the subsequent healing.

When the abscess has been laid open, it will be sometimes found that a large indolently inflamed gland appears at the bottom. Between such gland and the opposed textures no union will generally exist, and a probe may be passed around the circumference of the gland. Matter is apt to lodge in these intervals, and burrowing sinuses may follow.

These buboes are very troublesome; and by far the shortest course is to destroy the gland by caustic, or to put the patient under chloroform, incise the gland, and detach it with the handle of the knife or fingers, subsequently stuffing the wound with lint.

As this may appear a severe plan of treatment, it may be well to try first the effect of repeated applications of nitrate of silver or the red oxide of mercury, by which the gland-tissue is gradually destroyed, and contraction of the walls of the abscess may follow.

Sinuses, here as elsewhere, must be laid open; for it is very rarely that these heal rapidly by the injection of astringent and stimulating lotions. Of course, however, the effect of these can be tried before proceeding to the incisions.

When a sinus runs perpendicularly downwards—*i.e.* at right angles to the surface of the body—it should not be laid open. An enlarged and inflamed gland will often be found occupying the base of the sinus. By applying a strong caustic to this, and stuffing the part with lint, it may generally be made to heal from below. So soon as there is a healthy granulating foundation, the sinus will begin to fill up. If the process becomes chronic, it is a good plan to pass a narrow bistoury to the bottom, and incise the walls of the sinus, applying pressure afterwards.

During the whole treatment, the patient should live well, taking as much air and exercise as he well can, and steel with tonics are generally indicated.

Local treatment of primary syphilitic inflammation.—Regarding the primary adhesive inflammation as the portal through which the syphilitic disease enters a patient's constitution, the first question which naturally arises is, whether the poison may not be destroyed in embryo by caustic, while the disease is as yet local. The writings of many authors would lead to the belief that this might generally be accomplished, provided the patients came sufficiently early under observation. If the results of the application of the syphilitic poison were always immediately developed, and if the affection produced by it always ran a definite course, terminating, as has been so often erroneously described, in the specific pustule, nothing would appear more easy and simple than at once to destroy the disease. But it has already been shown (Chap. III.) that the description of the development of the suppurating sore does not apply to the infecting chancre; a period of incubation may here exist, lasting over days or weeks, and during this time there is no means of knowing what part will ultimately be proved to have received the poison. There is, therefore, in such a case, no possible means of judging where the caustic should be applied. At the end of this period, if the caustic be applied immediately the disease appears, it will not

prevent its progress. The poison has lain dormant for a certain period, and has been imbibed by the surrounding tissues. The destruction of a small portion of these will not prevent the development of the morbid action in the remainder. In cases, however, where the results of venereal inoculation have appeared shortly after the application of the poison, the application of caustic furnishes a most efficient remedy against the further progress of the disease. The destruction of the tissue involves that of the poison which it contains. The experience of Sigmund of Vienna coincides with that of Ricord and other observers in establishing the fact, that, if a part to which the venereal virus has been applied be destroyed by caustic within the first four days, no constitutional symptoms will follow; but, inasmuch as the characters of the infecting sore very seldom declare themselves within this period, the remedy is one which cannot be said to be applicable to such sores.

The indurated chancre does not ordinarily produce much inconvenience and, were it not for its consequences, would require little attention. It is true, indeed, that an indurated sore will sometimes become intractable, and be followed by a troublesome ulceration; but this occurs in general only where the patient's system has been infected with the poison, and where the local symptoms are a part of the secondary disease.

The object of treatment in the primary specific adhesive inflammation is to get rid of the induration; so long as this remains, the patient is never safe from its consequences.

Excision of an indurated part has sometimes been practised; but, as in the case of the application of caustic when the disease has declared itself, the remedy is too late. The cut edges of the wound always take on the specific action, but this induration is probably not so persistent as that of the part originally infected; so that, although there can be no reasonable expectation of cutting short the disease by this mode of treatment, the patients ultimately appear to do better than where the original adhesive inflammation is left to run its course.

The best local application is some form of mercury. The common mercurial ointment may be applied, spread upon lint; or calomel, combined with mucilage and lime-water, may be used in the form of a lotion; or the surface of the part may be dusted with calomel-powder. Solution of perchloride of mercury is also frequently used in the proportion of one grain to an ounce of water. The sub-bromide and perbromide of mercury may also be used, either externally or internally, in the same quantities as the subchloride or perchloride.

In cases where it an object to cure a primary ulceration quickly, perhaps the best application is calomel fumigation locally applied. As this remedy is efficacious in various other forms of syphilitic disease, its mode of application will be described separately.

CHAPTER VII.

SYPHILITIC INOCULATION MODIFIED BY PREVIOUS DISEASE: TWOFOLD INOCULATION.

As the effects of the vaccine inoculation may wear themselves out, so that a patient after the lapse of a certain time may be re-vaccinated, so may the syphilitic poison after a time occasionally reproduce the genuine infecting chancre upon the same individual. But it continually happens that patients constitutionally syphilitic are exposed to fresh infection before the influence of the first disease has passed away. The inoculation may then succeed in a modified form. A pimple, a small tubercle, or an abortive pustule may result; but these may all want the characteristic symptoms of the originally infecting disease. These modified actions are also peculiar in not having the period of incubation, which is natural to the original infecting sore. They commonly appear shortly after exposure, and are likely to occur generally in proportion to the irritating nature of the discharge, with which the poison is combined. Thus an indurated sore which does not furnish a secretion which would be

inoculable upon a person who had already had syphilis, might, if artificially irritated, become inoculable; or a secondary affection, which is not communicable under ordinary circumstances, may, when producing or combined with an irritating secretion, become communicable. Cases of this nature are continually presenting themselves in practice. The affections which result differ from those which constitute the ordinary forms of primary syphilitic infection, and they may safely be treated without mercury. The following cases illustrate this subject experimentally:—

CASE 1.—H. C. came under my care in the Lock Hospital on February 2, 1854. She had a syphilitic eruption upon the skin, and several irritable sores upon the inner margins of the labia and perineum. The inguinal glands were enlarged and indurated.

Feb. 4th. Several spots were inoculated from angry-looking sores on the margin of the anus and labia.

6th. Several fresh inoculations were performed from other irritable sores.

11th. Each point inoculated had produced a kind of pustule. Fresh inoculations were made with the secretions of the original sores, and with that of the artificial inoculations.

13th. Upon each point last inoculated a vesicle had appeared.

14th. The secretion of each vesicle had become turbid.

16th. Fresh inoculations were performed from the sores, natural and artificial, which furnished the largest amount of secretion. Eighteen hours afterwards the inoculated spots were found to be slightly reddened.

18th. Forty-four hours after the last inoculations no result was perceptible. Several fresh spots were inoculated with the secretion of the sores near the anus, and with that of the sores artificially produced.

22nd. The last inoculations had produced no effect. The inoculations of the 11th were forming small dry scabs. The eruption had now faded.

24th. Several spots were inoculated with as much secretion as could be obtained from any of the sores.

27th. The inoculations last made had produced no effect.

March 2nd. The sores, natural and artificial, had all healed. The patient was discharged as cured, having been under treatment exactly four weeks, and having apparently during the last two weeks not been susceptible of any further inoculation by means of the secretion derived from her own sores.

It was at first difficult to say why, in this case, some of the inoculations were capable of being reproduced, and some not; why those last made were of a different character from the first; and why the results of all the inoculations disappeared in so short a time.

These questions appear to derive a solution from the following two cases, which show that although an infecting sore is not capable of being inoculated under ordinary circumstances, yet the same sore will, under a state of irritation, produce an inoculable secretion, and that the effects of the inoculation of that secretion will vary according to the amount of irritation present at the time the secretion is produced.

CASE 2.—A lad was admitted into the Lock Hospital on July 29, 1858. He had had gonorrhœa six months previously, but otherwise had been free from any venereal affection until about a fortnight before his admission. He then had a superficial sore behind the corona glandis, which healed in a few days. Two or three days after the first appearance of this sore, a little pimple appeared on the outer skin of the prepuce. This, on July 26, presented all the appearances of a well-marked Hunterian chancre. It discharged from its surface a white turbid secretion. To a portion of this a drop of acetic acid was added, and it was examined by the microscope, and found to contain no pus globules.

July 27th. The secretion was inoculated in several points on the patient's thigh.

29th. This was the day the patient was admitted into the hospital. The secretion from the sore was again examined, and found to contain no pus.

31st. Several fresh inoculations were made. The sore continued to increase in size.

Aug. 3rd. None of the inoculations had succeeded. The glands at the back of the neck were now enlarged, and the skin presented an incipient syphilitic eruption. A small blister was applied to the surface of the sore.

5th. A superficial slough had formed on the surface of the sore, which yielded in parts a puriform secretion. This was inoculated upon the thigh in several points.

7th. The sore now again secreted no pus. Fresh inoculations were performed.

10th. The sore was dressed twice yesterday with the savine ointment, and now yielded a copious secretion of pus. This purulent secretion was inoculated in several points on a different part of the thigh.

12th. The inoculations last made had succeeded. The sore still yielded a copious secretion of pus.

14th. The inoculations both of the 5th and 10th had now succeeded, but not those of the 7th. They presented the appearance of circular red patches, with some elevation and thickening of the cuticle. In one place there was the appearance of a vesicle, from which a serous fluid exuded. This fluid was again inoculated upon the patient's thigh. The original sore, which had been dressed with water, now again yielded no pus.

17th. The inoculation from the inoculation had succeeded. It presented the appearance of

a red circular patch, with slight thickening of the skin, from which the cuticle was abraded. It had not in the least assumed the appearance of a pustule, nor was anything like pus secreted from its surface. A single pustule, surrounded by very little inflammation, had, however, formed in one of the points first inoculated.

19th. The inoculations appeared as separate red patches on the skin, which in these situations was slightly raised and thickened, but no induration extended into its substance. The solitary pustule which appeared had dried up.

24th. One of the inoculations first made had a slight tendency to ulcerate; the others were desquamating and losing their colour.

CASE 3.—Bridget C., aged 17, was admitted into the Lock Hospital on August 26, 1858. She had suffered from a thick yellow discharge between two and three months. This was followed, in the course of as many weeks, by the appearance of two small places on the upper part of the left thigh. These, upon her admission, presented all the characters of well-marked primary indurated chancres in a state of progress. The surfaces of these sores were covered by a scanty tenacious secretion, in small quantity, which upon microscopic examination, yielded no pus. This secretion was carefully inoculated upon the patient's thigh.

Aug. 28th. The inoculation was repeated. There was at this time no indication of the sores having any tendency to heal.

31st. No result from the inoculations. The two sores had now been dressed for two days with the savine ointment, and yielded an abundant secretion, distinctly purulent. The secretion from each sore was inoculated in several points close together in two separate places in the thigh.

Sept. 2nd. The inoculations last made have produced the appearance of small incipient pustules in both situations. The secretion from one of these was inoculated in two or three points on the thigh lower down.

4th. The inoculations from the inoculations had apparently succeeded. One of the inoculations of August 31 had produced a small pustule. The others had produced only vesicles. The skin over one of these was broken.

9th. The inoculations from the inoculations performed on September 2 have dried up. The inoculations first in order of August 31 had entirely lost their puriform character. They now appeared as circular patches, and yielded a serous secretion mixed with epithelial scales. The original chancres were now in process of healing.

11th. The inoculations first in order were desquamating, and of a light-red colour. The inoculations from the inoculations appeared as small red pimples, which were gradually losing their colour.

17th. The original chancres were cicatrised. The inoculations were fading and desquamating.

23rd. The inoculations from the inoculations were still visible, and appeared as shining scales of discoloured epithelium.

25th. A few faint secondary spots appeared on the body. The original sores were quite healed, leaving slight induration. The corresponding glands in the groin were still enlarged and hard.

Oct. 4th. This patient now left the hospital, but again presented herself on the 8th. The inoculations appeared as brown spots, the colour of which gradually faded into that of the surrounding skin.

It is quite possible that the persistence of the inoculations, and their peculiar colour in the two last-quoted cases, may have depended upon the syphilitic diathesis of the patients. But this in no way militates against the fact that inoculations succeeded at one time, while they failed at another, under precisely the same conditions of the general system.

In Case 1 the inoculations succeeded so long only as the sores furnishing the secretion maintained their irritable character, and failed as soon as this irritability subsided.

In Cases 2 and 3, the sore, the natural secretion of which could not be inoculated with the lancet upon the patient, furnished an inoculable secretion when artificially irritated.

In all the inoculations above recorded, the effects appear to have been in direct relation to the amount of irritation present, and generally in proportion to the puriform condition of the secretion inoculated. It might be supposed that in the first case the sores ceased to be inoculable because they were in a healing condition, but this would not account for the fact that the inoculations produced from them ceased to afford an inoculable secretion within four or five days of their appearance. The inoculation, then, of the secretion of a sore affected with specific adhesive inflammation may take place; but is not easily performed when once the patient's system has been affected with syphilis. When successful, the results are very

different from those which follow the inoculation of the secretion upon patients not previously syphilitic, or the inoculation of the secretion from naturally suppurating sores. In the latter case each puncture produces a pustule, which by repeated inoculation will produce its like a great number of times. The inoculation of the secretion from infecting sores upon patients previously syphilitic as a rule fails, or succeeds only under circumstances of accidental irritation. It then can be repeated a very limited number of times; and the results obtained, even by a number of punctures in one situation, are comparatively of a trifling description.

There is one circumstance which requires to be noted in connection with this modified form of inoculation, and which, unless duly understood, might sometimes lead to an erroneous diagnosis. It will occasionally happen that a patient, previously syphilitic, will become inoculated again in a modified form, and upon the point thus inoculated a secondary effusion of plastic material, dependent upon the first infection, may occur. The irritation produced by the modified inoculation will then become surrounded by a certain amount of induration, and this affection may then easily be mistaken for a primary infecting ulcer. Again, it will sometimes happen that a secondary induration upon the prepucial space (the consequence of a previous infection) will become abraded, or will ulcerate spontaneously. The appearances then produced are very similar to those which accompany the primary infection, and they are here particularly noted in order that these different diseases may not be mistaken for each other.¹

CASE.—M. H., aged 18, had previously suffered from syphilis. She was inoculated with the secretion of an infecting sore which had previously been irritated by the application of the savine ointment, and in another place she was inoculated with the secretion from a syphilitic ethymatous pustule in its natural condition. On the third day the first inoculation appeared to have taken; but on the eighth the appearances had faded. At the expiration of five weeks there was a slight accurately defined induration around the second inoculation.

CASE.—A woman, who, from her previous mode of life, had every chance of becoming syphilitic, was inoculated with the secretion from an infecting sore. A pimple followed the inoculation. At the expiration of a month the pimple was still there, and was surrounded by a faint brown copper-coloured eruption. These spots occupied a diameter of about six inches, and faded ultimately of their own accord. No other local or constitutional affection appeared as the result of the inoculation.

A modified syphilitic eruption, confined to the neighbourhood of a second inoculation on a patient previously syphilitic, is not uncommon. It is not unfrequently observed in women of the lower class. A syphilitic affection, presenting the distinctive characters of the primary infecting sore, more or less modified, will appear perhaps on some portion of the skin, and after a comparatively short interval an eruption will follow, confined to within a few inches of the modified inoculation. Any general mercurial influence is scarcely required for such affections.

Fig. IX. represents an indurated sore which was made to suppurate artificially. Fig. X. represents the inoculation from that sore, and Fig. X. A the inoculation second in order. The drawings were made on the eighth and ninth days respectively, and show the inoculations already fading away.

Sometimes, however, especially after the lapse of time, inoculations on a patient previously syphilitic may run much the same course, and be followed by the same symptoms as if the patient had not previously had syphilis.

A gentleman had a syphilitic sore, which was followed by a general eruption on the skin. He then passed two years in the West Indies. After this he returned home, with the faint brown stains of the eruption still visible. In London he contracted fresh disease. Two well-formed indurated and circular chancres presented themselves on the glans penis. In a few weeks these were followed by a well-marked crop of syphilitic lepra, of a bright copper colour, and quite distinct in appearance from the brown stains of the first eruption.

When a second infection occurs in this way after the lapse of some years, it is not in general attended with the same amount of enlargement of the inguinal glands, but something like the usual period of incubation exists between the application of the poison and the appearance of the symptoms. There can now be no doubt that a

¹ The inoculation of ordinary pus will, in certain states of a patient's constitution, be followed by a well-developed pustule.

patient's constitution may so far become free from the consequences of a syphilitic infection that, in exceptional cases, he may become infected a second time, and that the fresh infection may then run its natural course much in the same way as if no previous disease had existed; such cases, however, are rare. In general, if a second infection occurs, it is in a modified form; and if it should be followed by any constitutional symptoms, these present themselves also in a very mild manner.

In patients whose constitutions are under the influence of syphilis the period of incubation of a second infection is as a rule comparatively short.

It would therefore appear—

1. That after a first infection, and before the induration has appeared, a patient is susceptible of being inoculated again with the same disease, from the same or from another source.

2. That after the induration has appeared he is no longer capable of being inoculated with the syphilitic poison, except in cases where the inoculated matter is derived from a part which has been subject to considerable irritation, and that even then the inoculations produce comparatively little effect, and are not followed by any additional constitutional symptoms.

3. That after a certain time the effects of the first infection may, in a great measure, subside, and that then a modified form of inoculation may take place, which may be followed by fresh constitutional disease; but that this also, when it does occur, appears usually in a very modified form.

4. That this second infection is not likely to be accompanied by enlargement of the inguinal glands.

5. That the period of incubation of the second infection varies in inverse proportion to the degree in which the constitution is at the time influenced by previous disease.

The various forms which have now been described in which syphilitic inoculation may be modified, often render the diagnosis of a case in its early stages very difficult. If a case be seen once only, some accidental complication is particularly liable to lead to an erroneous opinion; but if the case be watched for a short time, there will seldom be any doubt as to its real nature.

Nature is, as I believe, always true to herself, and if interrogated fairly, she will furnish a faithful answer. But this answer is given at her own time and in her own way. If the surgeon demands an immediate response the first time he sees a syphilitic sore, he may be disappointed; but if he will carefully watch the course of the disease, he may with confidence rely upon the information he receives. If a persistent form of suppuration be established after inoculation, natural or artificial, *that* disease is of the non-infecting kind, as far as the patient's constitution is concerned. If the adhesive form of inflammation be established, although after the lapse of some weeks, secondary symptoms will follow. If both kinds of inflammation be present, then the patient has received a twofold inoculation, and each disease will run its course, modified, perhaps, by, but in spite of, the other (fig. VII.)

Twofold inoculation may occur either in the same or in different parts, at the same or at different times. When it occurs in the same part and at the same time, the results of the inoculation of the secretion from the suppurating sore will first develop themselves, and, subsequently, the results of the inoculation of the secretion from the infecting sore. This depends upon the different period of incubation which naturally belongs respectively to each kind of disease.

The cases which have led to the greatest confusion in practice are those in which the inoculation of the secretion from a suppurating sore has followed, after the lapse of three or four weeks on the same spot, as the inoculation from an infecting sore. We have, then, the results of two kinds of action, and their respective products, in close proximity. The suppurative inflammation does not, then, *prevent* the infection of the patient's constitution; the adhesive inflammation does not prevent the appearance of the 'suppurating sore.' The means of diagnosis, which would refer these mixed sores either to the infecting or to the suppurating class exclusively, are therefore absent.

Although in such cases it may be very difficult to form a correct diagnosis at once, yet by watching the course of the symptoms this may be done with much accuracy.



Fig. IX
Irritated undrained sore



Fig. X
Inoculation from the first chancre



Fig. X^a
Inoculation second in order from Fig. X



Fig. VII
Inoculated syphilis in a surgeon

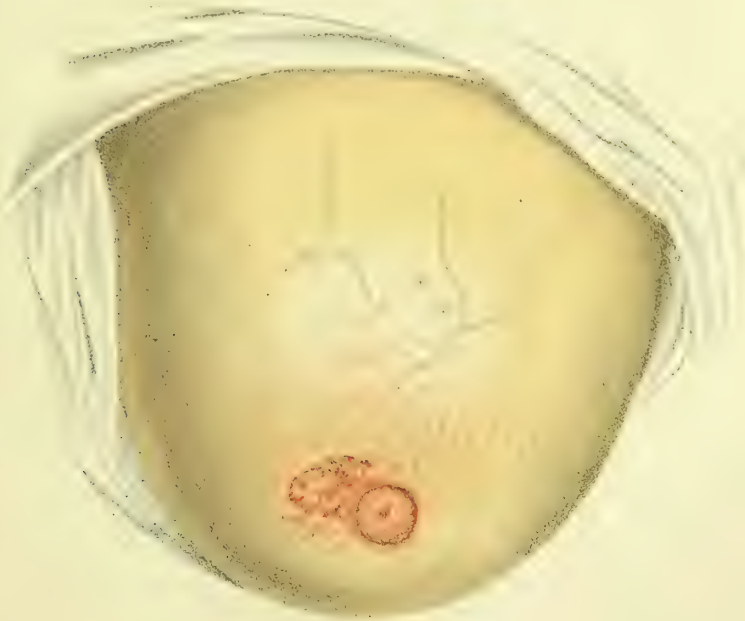


Fig. XI
Chancre on the breast



CHAPTER VIII.

TRANSMISSION OF SECONDARY SYPHILIS.

THE contagious character of secondary syphilitic affections was generally admitted before the time of Hunter. In the experiments which he made he was led to the conclusion that the products of constitutional syphilis were 'not capable of acting in some respects on the same body or same state of constitution as that matter does which is produced from a (primary) chancre. He says that the secretion from a chancre generally when absorbed produces a bubo, but that we never find a bubo arising from a secondary syphilitic sore. When there is a venereal ulcer in the throat, no buboes appear in the glands of the neck. Venereal sores on the arms, or even suppurating nodes on the ulna, do not as a rule produce swelling of the axillary glands, although these will very certainly be affected if syphilitic matter from a primary chancre be inoculated on the skin of the arm. Again, when syphilitic blotches or nodes form on the legs and thighs, the specific affection of the glands in the groin, which accompanies primary infection, does not occur.

These considerations so far biassed Hunter's mind, that he came to the conclusion that the secretions from the secondary syphilitic affections were not inoculable. He mentions, however, that it was asserted in his day that ulcers in the mouths of children derived from constitutional and hereditary disease, produced the same disease upon the nipples of women who suckled them. That is, the children were contaminated either by their mothers or fathers; the child received the disease by hereditary descent; and the nurse was infected by the child. 'If,' Hunter observes, 'it were possible to contaminate once in this way, it would be possible to contaminate for ever. How far the observations upon which the before-mentioned opinion is founded have been made with sufficient accuracy I know not.'

As has been already pointed out, Hunter committed the grave error, in which he was eagerly followed by a host of subsequent writers, of supposing, because the syphilitic poison was not inoculable as a rule upon the person who produced it, that, therefore, it was not inoculable upon a person who had not previously had the disease.

Experiments and observations have now been made with sufficient accuracy, and repeated a sufficient number of times, to show that the circumstances contemplated by Hunter actually do exist, and that syphilis may be communicated in this way, and that it may be so communicated from one patient to another an unlimited number of times, so long as the poison is brought in contact with a person not previously infected. With the increased light which modern investigations have shed upon this subject, it is not uninteresting to contemplate some of Hunter's own cases.

A child was supposed to have infected its nurse with syphilis. The parents had been married about twelve years. The mother fell into a weakly state of health, and miscarried of her third child at the end of five months. The fourth child came at seven months, but was puny, weak, and had hardly any cuticle when born. It was immediately after birth attacked with a violent disorder of the bowels, so as to purge blood. It died in a few days and was opened by Hunter. The whole skin was almost one excoriated surface. The intestines were much inflamed and thickened.

With her fifth child, from great care, this patient went eight months, and it was hoped she might go her full time, and also that this child might be more healthy than the former. When she was delivered the child was very thin, but free from any visible complaint.

Some days after birth, it became blistered in a vast number of places on its body. These blisters were filled with a kind of matter which broke and discharged a thinnish pus. The inside of the mouth was in the same condition. About three weeks after its birth it died.

Some weeks after the death of the child, the nurse's nipple, and the ringround the nipple inflamed, and sores or ulcers were formed with a circumscribed base. They were poulticed, but without benefit. She also complained of a sore throat, but the sensation she complained of was so low in the throat that nothing diseased could be seen. A swelling took place in the glands of the arm-pit, but they did not suppurate. She applied to a physician, and from the account she gave he pronounced her disease to be venereal, and that she had given suck to a *foul* child; and ordered ten boxes of mercurial ointment to be rubbed in on her legs and

thighs, eight of which had been used when Hunter saw her, and then her mouth was become extremely sore.

These circumstances came to the ears of the family, and an alarm took place. The husband went from surgeon to surgeon, and from physician to physician, to know if it was possible for him to have the disease for fourteen years, and never to have perceived a single symptom of it in all that time; or if it was possible he could get children with the disease now when the two first were healthy. He also wanted to know if it was possible for his wife to have caught the disease from him under such circumstances; and also, if she could breed children with this disease, although she herself never had a single symptom of it.

Hunter ordered hemlock, but that appeared to have no effect. While this was going on, eruptions broke out on the skin. The skin of the hands and fingers peeled off, the nails of both fingers and toes separated, and sores formed about their roots, which were all supposed to be venereal. She looked dejected and sallow. She was desired to go into an hospital, which she did. As soon as she got into a warm bed, and had good wholesome food, she began to mend, and in about five or six weeks she had got fat and almost well, the sore only about the root of the nail of the great toe had not healed; but that appeared now to be owing to the root of the nail being detached, therefore acting as an extraneous body. She came out of the hospital before this toe had got well, and by returning to her old poor mode of living the soreness in the mouth returned; however, she mended in the end without the use of more mercury.

Had not Hunter been deceived by his own experiments and come to the conclusion that constitutional disease could not be communicated by contact, such instances as he himself related must have led him to a different conclusion.

The following cases are among those which he has recorded, in which the disease was supposed to have been produced by the transplantation of teeth:—

A young lady had a tooth transplanted, and the tooth fastened extremely well. It continued firm for about a *month*, when the gum began to ulcerate, leaving the tooth and socket bare. The ulcer continued, and blotches appeared upon the skin, and ulcers also in the throat. The disease was treated as venereal, and the symptoms disappeared, but they recurred several times after very severe courses of mercury. She at last got well.

A gentleman had a tooth transplanted, and the tooth remained without giving the least disturbance for about a *month*. The edge of the gum then began to ulcerate, and the ulceration went on until the tooth dropped out. Some time afterwards spots appeared almost everywhere on the skin. He was put under a course of mercury, and all disease disappeared. Some time after the same appearances returned, with the addition of swelling in the bones of the metacarpus. He was now put under another course of mercury more severe than the former, and in the usual time all the symptoms again disappeared. Several months after, the same eruptions came out again, but not in so great a degree as before, and without any other attendant symptoms. He a third time took mercury, but it was only ten grains of corrosive sublimate in the whole, and he got quite well. The time between his first taking mercury and his being cured was a space of three years.

In the 'Medical Transactions of the College of Physicians of London,' published in the year 1785, Dr. William Watson, at that time the vice-president of the Royal Society, gives an account of the case of a young unmarried lady, about 21 years of age, who had a tooth transplanted into the socket of one of the incisors of the upper jaw. The new tooth fastened exceedingly well. It remained firm for a month, when her mouth became very painful. The gum became ulcerated, and part of the alveolar process was left bare. Before another month, the ulceration occupied the whole space under the upper lip between the teeth and nose. It extended likewise to the cheeks and throat. Blotches then appeared on her face, neck, and various parts of the body; several of these became ulcerated painful sores. After trying a variety of tonic medicines without benefit, two grains of calomel were ordered once or twice a day. She took about fourteen pills, when she was obliged to discontinue the use of the calomel, on account of the griping and purging. During the time that she was taking the pills the ulcerations of her mouth and cheeks did not spread, but were less painful, and of a milder appearance. The blotches on her face and body grew paler, and such of them as had ulcerated healed apace, and no new ones appeared. The mercurial inunction was now tried, but in ten or twelve days the griping and purging returned, and the ointment was discontinued.

The good effects of the mercury were, however, Dr. Watson observes, very apparent. The blotches all disappeared; the ulcerations in her face and body completely healed, and those of the mouth nearly so. A portion of the alveolar process subsequently exfoliated, and ultimately the patient died.

Dr. Watson remarks that the progress of this disease not being impeded by the most powerful antiseptics, and its giving way to mercurials, even in small doses, cannot but suggest that the disease was truly venereal.

At the time that such cases as the above were recorded, had not the idea taken

possession of some men's minds that absorption of syphilitic poison under the circumstances was impossible, the diseases described would doubtless have been assigned to their right cause.

In some of the cases care was taken to wipe the surface of the tooth before it was transplanted, and it was thought that by so doing every chance of inoculation would be prevented; but a brief reflection on some of Hunter's own experiments is sufficient to show how futile such a notion is. In the experiments which Hunter performed of transplanting teeth and other parts from one animal to another, it was clearly proved that each part of a living being has its independent vitality, which it can maintain for a certain time independent of the rest. In the Museum of the College of Surgeons there is now a tooth which Hunter transplanted into the comb of a cock. The tooth grew in its new situation, and when the cock died, Hunter injected the tooth through the blood-vessels of the cock. During the time that the tooth was withdrawn from its natural socket, and before it had acquired any fresh connection in its new bed, it maintained its own vitality. Subsequently its blood-vessels communicated freely with those of the cock, and their contents passed into each other.

Now it has clearly been shown that the blood of an infected person may, when inoculated, communicate syphilis. If, then, the tooth of an infected person be transplanted into the mouth of a person who never before has had the disease, the minute quantity of blood which it contains may be sufficient to infect the healthy person; and it is quite clear that simply wiping the outside of the tooth would not prevent such an occurrence.

It is not, however, only the blood of an infected person, or the secretion of what are usually called secondary sores, which may become the means of communicating syphilis from a person constitutionally affected to one who has not previously had the disease. There is reason to believe that the secretion of any of the mucous membranes of a syphilitic patient, when in a state of increased activity or of inflammation, may produce the same effect.

Dr. Marston, who has lately contributed a very valuable paper to the 'Medico-Chirurgical Transactions,' has, by quite an original and independent series of observations, arrived at very much the same conclusions as myself upon this subject; and his cases are the more valuable, since his opportunities, as an army surgeon, of ascertaining the exact condition of his patients during their illness and of observing them afterwards, are much greater than can ordinarily occur in private practice.

The following are among Dr. Marston's cases:—

Two men were admitted into hospital with gonorrhœa, Br. A. and Gr. S. The men came to hospital within forty-eight hours of each other, and were placed in contiguous beds. Gr. S. went with the police, and pointed out the source of his contagion. Br. A. went upon the same errand to the same house, and found the woman already removed. Gr. S. told me that, to their mutual surprise, they discovered that it was the same woman in each case. Both suffered from all the symptoms of gonorrhœa, and there was no suspicion to the contrary. Br. A. had suffered from syphilis before, Gr. S. never. After remaining in hospital a long time, Br. A. was discharged cured, and no further symptoms, so far as I could trace, appeared in his case. Gr. S.'s recovery was delayed from gleet and irritable bladder, for which instruments (No. 10 and 12) were used. They passed without difficulty, local tenderness, or hæmorrhage. After appearing anæmic and in ill-health, Gr. S. had sore throat (ulcerated tonsils) and a guttural voice; subsequently papules appeared on the inside of the lips and the buccal membrane, coincidently with psoriasis palmaris and 'nocturnal rheumatism.' The inguinal glands were slightly enlarged symmetrically. For these symptoms he took iodides of mercury and potassium, with mercurial vapour bath, by which means, after many relapses, he was cured. The case was shown to some surgeons, who, of course, suggested a concealed chancre ('chancre larvé' of Ricord). I passed sounds, and tried to discover a localised induration, without avail. If anything, perhaps the canal was firmer and more swollen to the touch than usual. Some urethral discharge was inoculated in the skin of thigh (at the time it was gleet and apparently prostatic secretion) without any effect.

The woman in this case, I learnt from the civil surgeon, had a vaginal discharge, but no primary ulcer that he could find. She was, however, suffering from acne of the face and a cutaneous syphilide.

Gr. C., five or six days after connection, had urethral discharge, and was admitted, as suffering under 'gonorrhœa,' by another medical officer. After the use of nitrate of silver injections and salines, as abortive treatment, he rapidly improved, but a slight gleet remained

for which the penis was blistered. This urethral discharge afterwards augmented in amount, and became most copious and purulent, and symptoms of cystitis set in. After having been in hospital eight weeks, he came under my care. Upon the dorsum of the penis were two large oval, indolent, indurated, raised lumps. To me they appeared chancres. The glands of both inguinal regions were passively enlarged. In answer to my questions, and without any suggestion whatever on my part as to their nature, he said, 'One has existed about forty-five, and the other about forty-six days, as near as I can tell. They gradually became and remained as you now see them, and they came, I think, from the discharge getting in contact with two sore places from which the skin had been removed after blistering.' In seventeen days both healed under the influence of mercury. I learn that a papular syphilide has since appeared upon the trunk. By a later report it appears that this man has again passed under treatment for marked anæmia, and ecchymatous sores upon the extremities.

Numerous cases similar to those of Dr. Marston have occurred under my own observation.

A surgeon in much practice in Tyburnia brought a young gentleman, who was supposed to have gonorrhœa only, for my opinion. There was a discharge from the urethra, but in addition there was a small circumscribed induration on one side at the junction of the glans with the prepuce. This was not accompanied by any ulceration, and might easily have escaped detection. There was in my mind no doubt as to the nature of the case, and I at once told the surgeon and the patient that secondary symptoms would follow. My prediction was but too surely verified.

It is by no means always easy to say whence the secretion is derived which contains the infecting matter. I have lately had under my care three medical men, each of whom had become infected in their hands during their attendance upon midwifery cases. In one of these instances craniotomy had been performed, and in attempting to extract the child the surgeon had his finger between the bones of the foetal head. A pain then occurred, and pressed the bones violently against the surgeon's finger; an abrasion was the consequence. At the expiration of four weeks, a phagedænic-looking sore, surrounded by induration, appeared on the finger at the part corresponding to that which had been injured by the foetal bones. This was followed by secondary symptoms, with extreme depression. For several years this gentleman was unable to attend to his business, but ultimately his health was entirely restored by a course of calomel baths.

In a second instance an indurated sore formed on the finger of a medical man, and his health was entirely broken down by the symptoms which followed. This case was complicated by the occurrence of secondary abscesses.

In the third case, the surgeon would scarcely believe that the small irritable indurated spot which had formed on the side of his forefinger could have been the original cause of his failing health. The subsequent history of the case, however, fully revealed the real nature of the disease. The drawing (fig. VIII.) represents an indurated primary tubercle on the hand of another medical man, which was but too surely followed by secondary symptoms.

Susan B., æt. 66, presented herself at King's College Hospital on October 24, 1853, with a scaly, copper-coloured eruption raised above the surface of the skin, and having in some parts a tubercular appearance. She had also a well-defined and extensive indurated sore on the lip. She stated that she never had any venereal affection, and had given birth to twelve healthy children.

Eighteen months before applying to the hospital she had noticed a pimple on the inside of the upper lip, which contained a little clear fluid. This broke, and a small sore formed, which, however, again healed in about a month, leaving a circumscribed induration. Three weeks ago the sore again broke out, and gradually extended until the date of her application at the hospital. An eruption made its appearance between three and four months from the first commencement of the pimple on the lip, and this had continued to recur at intervals ever since.

This old lady had taken her granddaughter to nurse, and having become exceedingly fond of it, was in the habit of constantly kissing it. Her son, she knew, had suffered from some venereal disease five months previous to the birth of the child; her daughter-in-law had died a few days after her confinement, and had not suckled her infant, which was consequently brought up by hand. When the child was ten weeks old, some sores appeared on its tongue and lips. These were followed, a week afterwards, by an eruption on the nates, which was still visible when the grandmother applied at the hospital, and was clearly of a syphilitic nature. This woman might have, and probably often did, kiss her son with perfect impunity, but the syphilitic poison appears to have acquired increased activity with the new life of the child, and with that increased activity to have become more readily communicable by contact.

The wife of a missionary applied to me with her husband, on January 1, 1861. She was the mother of a healthy family, and until recently had enjoyed good health. She had kept a kind of home for destitute girls, and to one of these girls, who was subsequently known to have been a patient of the Lock Hospital, was entrusted the care of this person's baby. After the lapse of a certain time the baby had a well-marked syphilitic eruption on the body and nates, the mother remaining in the meantime quite healthy. Four months after the

affection showed itself on the baby the mother had characteristic symptoms of secondary disease. I had an opportunity of tracing the course of the disease both in the child and in the mother; but, although every effort was made, I could never discover how it was that the child first received the disease, or by what means it was communicated to the mother. But the whole of the circumstances left no doubt whatever on the minds of any who witnessed the case that the disease had been given, by the girl who was taken into the missionary's family, to the baby, and that it was communicated by the child to its mother—an interval of four months having occurred between the first appearance of the symptoms in the child and in the mother.

One of the most interesting cases proving the inoculability of the secretion from a syphilitic patient, is one that occurred to Hunter himself, and which from being misinterpreted led many subsequent writers to doubt its accuracy. It, however, shows clearly enough that the irritated and inflamed mucous membrane of the urethra may furnish at the same time a secretion resembling that of a simple gonorrhœa, and also the poison which will give rise to an infecting chancre. Hunter inoculated himself on a Friday with matter from a patient supposed to be suffering from gonorrhœa. On the Sunday following there was a sense of itching which continued until the Tuesday. The inoculated part now appeared as a speck, was red and *thickened*. By the Tuesday following the speck had increased and discharged some matter. Caustic was applied and the sore healed, but four months afterwards it broke out again. It healed and opened again several times. A swelling took place in the right groin. This was followed by an ulcer on the tonsil and copper-coloured blotches on the skin. The disease recurred more than once on the tonsil and on the skin, and was ultimately cured by mercury at the expiration of three years.

The same disease which Hunter conveyed to himself in the secretion from the inflamed mucous membrane of the urethra may readily be communicated by the secretion from the diseased mucous membrane of the mouth in syphilitic patients.

The communication of the infection from one adult to another by the same means is not very uncommon.

A young woman had an eruption which was supposed to syphilitic. Upon being questioned upon the subject she indignantly denied the possibility of such being the case. When I saw the eruption, and the accompanying sore throat, I had no doubt whatever as to its specific nature. I found on the tongue a raised, circular, hard lump, and the submaxillary lymphatic glands were in a state of chronic induration. This patient submitted to an examination. There was no enlargement of the glands in the groin, and the hymen was perfect. Upon inquiry it was ascertained that this patient was in the habit of using the same spoons as another servant who was known to have a syphilitic affection of the mouth. The mode of entrance of the syphilitic poison in this case was indicated by the persistent induration on the tongue, and by the corresponding chronic multiple enlargement of the submaxillary lymphatic glands.

A young gentleman about to be married had a well-marked circular induration, superficially excoriated, on his tongue. The submaxillary lymphatic glands were in a state of chronic indolent enlargement. The patient maintained that his symptoms could not be syphilitic, but admitted, upon being closely questioned, that he might have caught the disease on his tongue from the lips of an infected person. The nature of the disease was fully proved by the appearance, in a short time, of a very well-marked general syphilitic eruption.

M. Rollet has recorded a very striking case in which the disease was transmitted by the mouth from one individual to another, and from him to a third.

A. S. had primary syphilis in 1858, followed by a papular syphilitic eruption, and excoriations on the lips. This patient was a glass blower, and in his occupation passed the tube through which he blew to another workman who carried on the process.

This second workman had in October a hard lump the size of a cherry-stone on the anterior surface of the right side of the lower lip. The corresponding lymphatic glands became specifically affected, and on December 10 he had ulceration of the throat.

This patient passed the tube in his turn, after he had done his part, to another workman (F. G.) who completed the process. This third workman in December had several ulcerations on his lips, and a mucous tubercle at the back of the throat, with pain in swallowing.

The following case was communicated to me by Dr. Marston, to whom I am much indebted for many valuable suggestions in reference to the present subject:—

‘A gentleman was suffering from symptoms of constitutional syphilis. Besides other symptoms, he had some fissures and epithelial ulcers upon the inside and angles of the lips. These were certainly not primary, but a part of the secondary symptoms under which he was suffering. He stated that he feared he might have infected a female, by labial contact. From the nature of her symptoms I inferred that his fears were well grounded. In due course of time, this female suffered from constitutional syphilis, and was treated for such by some eminent professional men.

‘The first symptom in her was an irritable-looking and indolent fissure upon the mucous membrane of the lower lip.’

M. Rollet is of opinion that a gonorrhœa in a syphilitic patient will not communicate syphilis. In this opinion as a rule he is probably correct, inasmuch as we

know that the products of other morbid poisons, when inoculated from a syphilitic patient, will produce only the specific disease in which they originated.

But the case is very different when a purulent discharge originates or is continued in a syphilitic patient, independent of any adventitious cause. This secretion may then, without any distinctly recognised form of secondary syphilis, communicate the specific morbid action in which it had its origin. The viscid muco-purulent discharge which flows from the neck of the uterus in a state of chronic inflammation, in a syphilitic patient, may, doubtless, communicate a discharge (not necessarily gonorrhœal) to a man, and that discharge may be the means of conveying syphilitic infection.

In the cases of this nature which have fallen under my own observation I have thought the discharge more viscid and tenacious than that of ordinary gonorrhœa, not accompanied by the same amount of ardor urinae, and of shorter duration.

But it is evident that a twofold disease, each of a specific nature—viz. a real gonorrhœa and a genuine syphilitic infection—may in this way be conveyed. This point is well illustrated by the following case. On May 6, 1861, I received the following in a letter from a well-informed surgeon in large practice :—

‘ Mr. — came to me in the middle of February, with acute gonorrhœa, which was relieved by ordinary treatment in about five weeks.

‘ Early in April, nearly six weeks after I had seen him, a sore appeared on the prepuce, which I thought was an excoriation produced by the gonorrhœal discharge. After a few local applications this healed, but after healing it became surrounded with an indurated circumference, which makes me suspect venereal mischief.’

In due course this induration was followed by well-marked secondary symptoms.

The natural secretions of the body, when the structures producing them are in a healthy state, cannot, in my opinion, be the means of communicating syphilis to another person, although the patient from whom these secretions are derived be constitutionally syphilitic. The following case may illustrate this subject :—

A married woman was admitted into St. George’s Hospital, on October 5, 1864. After her last confinement (having been previously quite healthy), she took a child to nurse in addition to her own. The strange child proved syphilitic. The woman had an ulcer on the breast, which was followed by a well-marked syphilitic eruption (see fig. XI.). This woman had taken the precaution to keep each child to one breast; and, although her own child was allowed to suck for six weeks after the eruption had appeared, yet it remained unaffected.

We have here the natural secretion going on in a syphilitic mother; the organ itself, which produced it, not being specifically affected. We have the constant contact of a diseased and healthy person, and the transmission of the secretion from one to the other, and yet no disease is imparted.

Few of the natural secretions of the human body have been accused of being the means of communicating syphilis. The saliva and the semen are perhaps, besides the milk, the only two which are supposed to be capable of transmitting the disease. There is no reason why these secretions in themselves should be more susceptible of the syphilitic poison than any of the other natural secretions of the body. If the organs which secrete them are not specifically affected, we cannot see why they should be more likely to contain the syphilitic poison than the urine or the bile. Now, all the secretions, before they pass out of the body, have to pass over tracts of mucous membrane. Mucous membranes are peculiarly liable to secondary syphilitic affections; and, if the secretions in question become mixed in the passage with the products of specific inflammation, we may readily understand how they may be the means of carrying the disease, although, by themselves, they may have no power of communicating it. The fitful and uncertain way in which syphilis is imparted by hereditary transmission from the father, and the very small number of cases in which it has been supposed to be transmitted by the saliva, seem to point rather to some accidental causes of contamination than to any inherent disease in the semen or in the saliva in syphilitic subjects. Such accidental causes at once present themselves to our minds when we contemplate the admixture of the diseased secretions of the mucous membranes with the proper secretions of the glands.

The conclusions to which I have arrived myself, and which I would submit for the consideration of others, are :—

1. That syphilis is communicated by the secretions from both primary and secondary syphilitic affections.

2. That the secretion of other specific diseases existing in syphilitic subjects have no power of imparting constitutional syphilis.

3. That the natural secretions of glands in syphilitic subjects, when those glands are not themselves specifically diseased, have no power of imparting constitutional syphilis.

CHAPTER IX.

HEREDITARY TRANSMISSION OF DISEASE: VACCINO-SYPHILITIC INOCULATION.

IF it be true that a patient is generally liable to syphilitic infection once only in his lifetime, the question presents itself with much point, how far a person who has had syphilis by hereditary transmission is protected from any fresh attack of the same nature. Several cases have lately come under my notice in which the effects of hereditary syphilis have manifested themselves as the patients were approaching puberty; and it is more than probable that if the visible effects of the disease can remain for years in a patient's constitution, its more subtle and secret influences may continue to a much later period. It is a point of very grave moment to determine how far such an influence derived by hereditary descent may have the same effect in preventing the re-inoculation of syphilitic matter, as it is well known that acquired syphilis has.

Whatever may have been the cause of the failure of the inoculation, where the products of secondary syphilitic affections have been artificially inoculated upon those who were said not previously to have had the disease, it is obvious that one link in the chain of evidence has hitherto been wanting in those cases.

In order to be of any real value in demonstrating the non-inoculability of secondary syphilis, it would be necessary to show that the patients upon whom the experiments were made were susceptible of *primary* syphilitic inoculation. If in any case it were found that a patient showed no syphilitic symptoms after being repeatedly inoculated with the secretions from secondary syphilitic affections, and if afterwards the inoculation of the secretion from a primary infecting sore gave rise in him to an infecting chancre, then we might say that such an experiment was of some value in proving the non-inoculability of secondary disease. But until the susceptibility of a patient's constitution to syphilitic infection from *any* source is thus demonstrated, the negative evidence derived from his not being susceptible to infection from any particular form of disease is of little moment.

Among those who habitually expose themselves to syphilitic infection, it occurs every now and then that an individual is found who never has had the infecting form of the disease; and the question naturally arises, Why has he not suffered in the same way as others who have been similarly exposed? The answer which would generally be given to such a question would probably be, that it depended upon some peculiarity in the person's constitution. But we are bound, if possible, to ascertain and determine, as far as may be, what that peculiarity of constitution is. If we say that a patient can have syphilis once only during his lifetime as a rule, and if we find that a certain number of children have hereditary syphilis, does it not appear probable that these children, when they grow up, would have some kind of immunity from further infection; or that, if the disease did appear again in them, it would be in a greatly modified form?

Modern researches in this branch of science bring us back to that which shrewd observers, without the advantages which we at present possess, had long ago noted. In 1812, Dr. Ferguson came to the conclusion that syphilis had become so much

mitigated in Portugal, by reason of general diffusion or other causes, that after running a mild course it exhausted itself, and ceased spontaneously. Dr. Ferguson further mentioned that he had reason to believe that at that time, in other countries, the disease had become modified in a similar way. He mentions that in certain German regiments, and in some districts of the Russian empire, the medical attendants had found that mercury was not necessary for the treatment of syphilis, and that, in the patients to whom he referred, the disease from being allowed to run its course probably for ages, had become as weak as it was found to be in the Portuguese. All adventitious diseases, says Dr. Ferguson, that are not connate, endemic, nor sporadic, appear more or less to run this course of exhausting themselves while retained upon the same ground to which they have been transplanted; but let the field be changed, and fresh sources of development be presented, and they will instantly resume their primary powers, and, taking a fresh departure of violence, repeat the almost forgotten inflictions of their original visitation. The powers which they thus acquire bear some resemblance to a phenomenon which is everywhere observable in the vegetable kingdom. The same species of seed may be sown upon the same ground until it shall so degenerate in point of vigour, as to become almost incapable of reproducing itself; but let it be changed to any other kind of soil, though even of far inferior quality, and it will immediately display new powers of life, and fructify and vegetate with its native strength.

Corresponding with this description appears to have been the effect of inoculation of the exhausted syphilitic virus of Portugal into the constitution of the British or other strangers. It was in some measure new, therefore unfriendly, and seems to have had the power of exciting new actions of more than ordinary violence.

The Portuguese, through apathy, and at a dreadful price levied on the generations that are passed, and never in all probability to be redeemed by their descendants, appeared to have gained a great exemption from both syphilis and variola; but the price is too high for us ever to offer up our bodies to be the unresisting subjects of disease, the fatal consequences of which, though they might go far to extinguish one or two ills, would be felt in the deterioration of our race to the most distant ages.

The same facts, with regard to the modified form in which syphilis appears in some of the lower classes of the community, have been observed in our own country.

Mr. Rose, formerly surgeon to St. George's Hospital, found from experience conducted at one time on a large scale in one of the regiments of the Guards, that he could treat syphilis when it appeared amongst the common soldiers by topical applications alone. It is true, that at the time Mr. Rose conducted his experiments, no clear distinction was drawn between those venereal affections which, if left to themselves, would infect the constitutions of the patients, and those which would not; and therefore a great many sores were, no doubt, said to be cured without mercury which, under no circumstances, would have been followed by secondary symptoms. It is exceedingly probable, however, that a certain proportion of the cases treated by Mr. Rose really depended upon the infecting variety of the disease; and as Mr. Rose found that he could deal with these cases without administering mercury, we can only conclude that the disease he was treating had appeared in some modified form, such as Dr. Ferguson had noticed in Portugal, and such as he states to have existed also in Germany and in Russia. As soon as Mr. Rose tried his plan of treating syphilis without mercury amongst the officers of the regiment in which his experiments had been made, the plan was found to be unsuccessful; and we have the authority of Sir Benjamin Brodie, who witnessed these experiments, for stating that, in private, Mr. Rose treated syphilis with mercury like other medical practitioners; and that in cases where he did not administer it, he was continually becoming involved in difficulties.

To what, then, is to be attributed this comparative immunity to the severer forms of acquired syphilis, and the modified form in which it has been occasionally noticed, not only in Portugal, in Germany, in Russia, but also in our own country? The answer to this important question arises out of the observations already made. That which Dr. Ferguson observed in his day may be seen at present. A person

who has had hereditary syphilis in his youth will either not contract the infecting form of syphilis in after life, or will have it in a modified form. An extensive observation of cases as they occur in public hospitals will at once show that syphilis as it presents itself among those classes who are likely to have inherited the disease, is a different affection from that which is observed under other circumstances. The same law may be traced in the history of individual cases. Instances have come before me where patients, the offspring of parents supposed to have been syphilitic, have shown some modified syphilitic symptoms for many years after they have grown up; and these patients have appeared comparatively insusceptible to any further infection. But it may be said that certain individuals, who have never shown any symptom of either hereditary or acquired disease, are also apparently not capable of receiving the infecting form of syphilis, or, if infected, that they have the disease in so mild a form as not to require mercurial treatment. The explanation of the occurrence is even in these cases not difficult. An instance lately came under my notice, where a woman, with the remains of what I believed to be a syphilitic eruption, had been impregnated ten times. Seven of the children had died, either from the premature confinement of the mother, or within a year or two after their birth; of the remaining children, two had eruptions which were treated with mercury, and one only never had had any symptom of hereditary disease. Shall we say, in this exceptional case, that because the visible symptoms of any hereditary affection were wanting, therefore something like the same diathesis was not communicated to her as to the other children? Or are we quite sure that hereditary syphilis, like gout and certain other diseases, may not pass over some individuals, or even a generation (as far as its sensible effects are concerned), again to appear in some modified form in their descendants? It would obviously be wrong, in the case of any hereditary disease, to say, because the symptoms were absent in an individual, or in one generation, that therefore the diathesis had ceased; and we know not yet through how many generations the latent effects of hereditary syphilis may not produce *some* influence. A man advanced in years, whom I knew from seeing him in a London hospital, and who had formerly had a variety of venereal affections, had a grown-up family. One of his daughters had an eruption on the skin at about seventeen or eighteen years of age, which eruption was treated with sarsaparilla. One of the sons, although he had frequently exposed himself to contagion, never contracted syphilis. This son married, and had a family. After a time his wife had an eruption on the body which was supposed to be syphilitic, and yielded readily to anti-syphilitic remedies. Last of all, the son himself had an eruption exactly resembling that of his wife. This I had an opportunity of seeing, and believe it to have been a mild and modified form of hereditary syphilis, which had then developed itself in a visible form for the first time. Had this son been one of Mr. Rose's patients, he no doubt would have been successfully treated without mercury; but it would be a grave mistake to suppose that syphilis in what has been called a virgin constitution can be treated in the same way.

CASE.—A young woman had an eruption for the first time after the age of puberty. This I considered to be syphilitic. The origin of the syphilis could, however, in no way be traced, until one day I accidentally saw the mother; the eruption on the mother's arm and on the daughter's chest are represented in figs. XIII. and XIV.

Several cases have come before me during the last few years in which symptoms to all appearance syphilitic could only be explained by hereditary transmission. In some of these there was a distinct history of syphilis on the father's side.

Dr. Viennois, in his thesis presented to the Faculty of Medicine in Paris in the year 1860, and also in the 'Archives of Medicine' for the same year, has collected together and given a detailed account of some cases in which an infecting syphilitic sore, or, more properly speaking, the specific adhesive inflammation, followed vaccination. Dr. Viennois has carefully excluded those cases in which a fresh set of symptoms followed vaccination in patients who had previously had hereditary or acquired syphilis, and has confined himself to cases in which the primary affections could be clearly verified, and their effects upon the constitutions of the patients

satisfactorily traced. Dr. Viennois' investigations led him to the belief that, if the lymph from a vaccine vesicle be alone inoculated, the cow-pox alone will be produced; but that if, in addition to this, the blood of a person affected with constitutional syphilis be inoculated at the same time, then syphilis may also be communicated. The cow-pox would then appear first, as having a shorter period of incubation; and after a time the syphilitic tubercle (or primary specific inflammation) would make its appearance upon the inoculated part, and would in due course be followed by secondary symptoms. The cases which Dr. Viennois has collected are related with so many circumstantial details, that, if correctly reported, they cannot fail of themselves to establish the fact that the poison of syphilis, and that of the cow-pox, may be communicated, and sometimes have been communicated, at the same time (fig. XII.)

During the period of doubt and suspense which followed Dr. Viennois' publications, two most remarkable circumstances took place. One of these was an artificial inoculation performed at the Hôtel Dieu; and the other the transmission of a disease, both by artificial inoculation and by natural means, to a large number of children, and to several adults at Rivalta in Piedmont. These circumstances have occurred at the exact time in the history of syphilitic inoculation best calculated to dissipate the doubts which still hung over so many minds, and the symptoms which they present will, I believe, if fairly interpreted, satisfy every unprejudiced inquirer. The first of these remarkable facts occurred in a woman eighteen years of age, who was admitted into the Hôtel Dieu, under M. Trousseau. This woman was vaccinated while in the hospital, in the beginning of October. The day after the vaccination the punctures were prominent, and surrounded by a slight inflammatory areola, with intense itching. Four or five days afterwards there were no longer any traces of the inoculation. This excited no surprise at the time, as the patient had previously been properly vaccinated. The patient left the hospital on November 9. In the beginning of December, two ulcers, covered with thick scabs, were seen on the inoculated spots. These ulcerations were at first considered to be vaccine vesicles abnormally developed, with an unusually prolonged period of incubation. On January 11, 1862, upwards of three months from the date of the vaccination, this patient was readmitted into the Hôtel Dieu. At this period the ulcerations on the arm were still unhealed; the corresponding armpit was the seat of multiple indolent bubo; and on the body, the arms, and the chin, was a syphilitic roseola, concerning the nature of which no one has hitherto expressed any doubt. The patient reported that this eruption had existed from the middle of December. It was followed by pains in the head, and indolent enlargement of the post-cervical glands.

M. Ricord now examines the patient at M. Trousseau's invitation, and reports that she is the subject of two indurated chancres on the left arm; that she has multiple enlargement of the glands in the axilla; and that she has specific roseola, typical of constitutional syphilis. This constitutional affection he moreover declares to have had its origin, its entrance into the patient's system, through the ulcerations on the left arm.

A much more startling series of facts have comparatively recently been brought to light by a sad tragedy enacted at Rivalta. Here a child, named Chiabrera, was vaccinated; from him another child name Mazone, was vaccinated; with forty-five other children. Chiabrera we shall call the first vaccinifer, and Mazone the second vaccinifer.

A disease was conveyed from the first vaccinifer to thirty-nine children; from the second vaccinifer to seven children. Both vaccinifers were very ill, and one died three months after vaccination. The first vaccinifer communicated the disease to his mother; the second to his wet-nurse. Twenty nurses or mothers were known to have been similarly affected. In three cases the same disease was again communicated from the mothers to their husbands; and in three other cases the disease was communicated to other, previously healthy, children.

The annexed diagram furnishes a view of the progress of this terrible malady, previously (as would appear) unknown at Rivalta, a village containing not more than two thousand inhabitants.

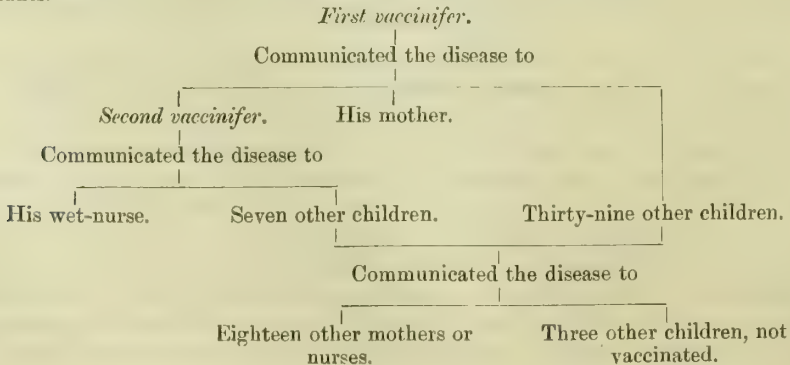




Fig. XIII
Prutia in daughter at puberty



Fig. XIV
Mother

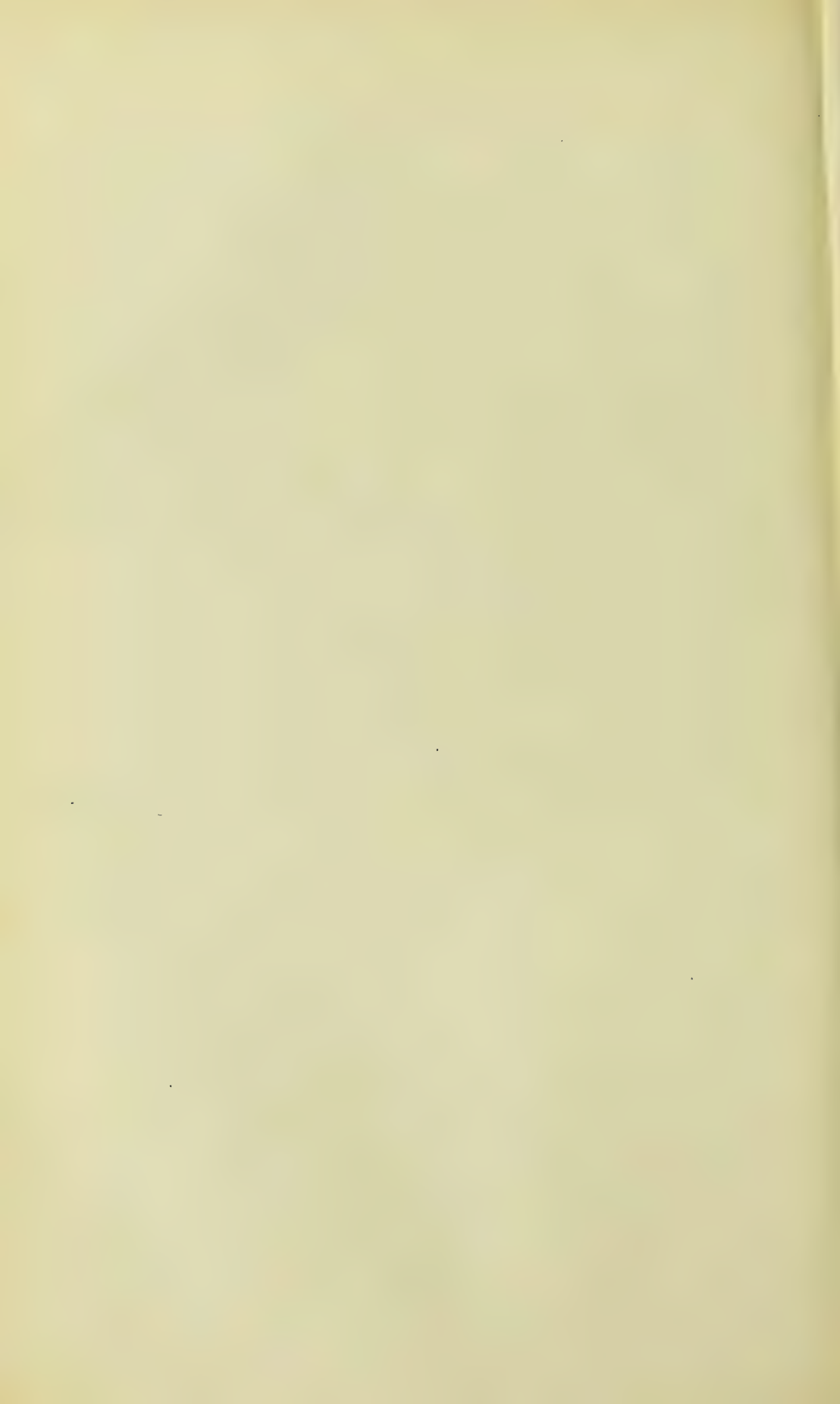


Fig XII



Fig XII^a

Vaccina syphilis



Figs. XII. and XIIA represent vaccino-syphilitic inoculations at the time the secondary eruption appeared in a case for which the author is indebted to Dr. Druiitt.

A second series of cases, of a like horrible nature to those which occurred at Rivalta, is related by Dr. Marone to have happened at Lupara. Dr. Marone ascribes the cause of the inoculation to the admixture of some blood with the vaccine lymph, and this is the explanation which is now generally received.

It has been demonstrated by direct experiment that the blood of a syphilitic patient (in certain states of the constitution) may be directly inoculated so as to produce a primary syphilitic sore.

On February 6, 1862, Professor Pelizzari inoculated Dr. Bargioni with the blood of a syphilitic patient, who had not been subject to any specific treatment.

On the morning of March 3, Dr. Bargioni announced to Professor Pelizzari that in the centre of the inoculated surface he had noticed a trifling elevation which produced a little itching. Professor Pelizzari examined the arm, and found, at the point indicated, a small papule, of a roundish form, and of a dull-red colour. There was then no induration at the base of the papule, nor any enlargement of the corresponding axillary glands. To prevent its being rubbed, it was covered with dry charpie and diachylon. Professor Pelizzari examined it daily. On the eighth day the papule had augmented to the size of a twenty-centime piece. On the eleventh day it was covered with a very thin adherent scale, resembling silver paper, which, upon the two succeeding days, became denser and less adherent, and in its central part commenced to crack. On the fourteenth day two axillary glands became enlarged to the size of nuts, and were movable and indolent. The papule remained indolent, but its sensibility was slightly increased. On the 19th, pressure upon the crust caused a small amount of seropurulent matter to exude from beneath its edges, the pressure giving a little pain. The axillary glands had now become larger and harder, but continued indolent. There was no induration apparent at the base of the papule. On the 21st the scale was transformed into a true crust, which had commenced to be detached at its edges; and the part beneath was ulcerating. Slight induration now appeared at the base. On the 22nd the crust was detached, and a funnel-shaped ulcer presented itself, with elastic and resistant borders, forming an annular induration. These edges were swollen, adherent, and obliquely inclined towards the base of the ulcer, which was covered with a very small amount of secretion. The pain was trifling. Dry charpie only was applied. On the 26th the ulcer had extended itself to the size of a fifty-centime piece. It secreted more, and the surrounding induration was considerably increased. Up to April 4 this ulcer remained stationary, but at that date, its base appeared to be granulating. The corresponding glands remained swollen, hard, and indolent. There appeared at this date trifling nocturnal pains in the head, and the posterior cervical glands became somewhat enlarged. On April 12 there appeared upon the surface of the body, particularly upon the sides of the chest, and in the hypochondriac regions, spots of irregular form and of rose colour, unattended by any inconvenience to the patient. The glandular swellings of the neck were well marked. This eruption extended itself, and became more confluent during the succeeding days. No constitutional disturbance, heat of skin, nor pruritus, accompanied this eruption, which went on increasing for eight days. On the 20th the cervical glands had increased in size, and were harder. The chancre maintained its specific character, and exhibited no tendency to cicatrisation. On the 22nd the colour of the eruption was decidedly coppery. Small lenticular papules were now perceived to be mixed with the erythema. The edges of the chancre had begun to granulate. Mercury was now commenced.

CHAPTER X.

CONSTITUTIONAL SYPHILIS.

THE symptoms known as those which constitute secondary syphilis usually manifest themselves within the third month after the introduction of the poison into the patient's system.

The access of this series of symptoms is usually marked by a certain amount of general disturbance. The patient feels feverish and uncomfortable; the skin becomes dry, and the tongue perhaps coated. It occasionally, however, happens that the secondary or constitutional symptoms show themselves without the patient feeling any general inconvenience.

Lassitude, weariness, and pain in different parts, frequently mark the progress of the disease. The skin loses its fresh and healthy colour, and assumes often a sallow hue.

When the general system is thus affected by the syphilitic poison, it is probable

that the nutrition of every part of the body may be thereby influenced. The same tendency to the separation of a plastic material from the other elements of blood may be manifested in any part of the body as in the original seat of the disease. These effusions are more or less organised, and take their characters from the structures in which they are formed. Thus, in the skin, the papillæ become inordinately developed; and if several of these unite together tubercles are formed. On the iris, the lymph effused forms fibrous bands, which unite it to adjacent parts and prevent its actions. If the periosteum of a bone be affected, the effused material ultimately becomes converted into new bone; and this process, from the unyielding nature of the parts, is attended with much pain, experienced chiefly at night, which has been supposed to be the period of growth. According to the constitution of the patient, the part affected may take on the adhesive, the suppurative, or the ulcerative form of inflammation; or any of these may terminate in gangrene, molecular or in larger masses. Hence a syphilitic affection which commences as a pimple, may at a subsequent period suppurate, or ulcerate, or a portion of its surface may be thrown off as a small slough. Different names have been given to these different forms of disease; but it is obvious that, as long as they are liable to pass into each other, no very accurate divisions can be made. Again: a division has been made with regard to the time at which different parts of the animal economy are affected. The skin, the throat, the eye, and the absorbent glands, are those in which the disease generally appears in the earlier stages of the complaint; and diseases of these parts have been called secondary symptoms; whereas the fibrous and osseous tissues and the deeper structures are, as a rule, affected later, and affections of these have been called tertiary symptoms. This distinction will be adopted for convenience of description, but it must not thence be inferred that there is any well-marked natural division; and, in fact, the so-called tertiary symptoms sometimes appear before the secondary, and the parts belonging to these respective classes are constantly found affected at the same time.

SECONDARY SYMPTOMS.

The specific induration around the infecting sore has been regarded as the first of the secondary affections. This is, however, not attended with any of the constitutional symptoms above referred to. At an uncertain date, but generally from four to seven weeks from the first appearance of this induration, the syphilitic fever, often very slightly marked, will occur; and in a great majority of instances this will be followed by an exanthematous eruption of the skin, often accompanied by sore throat. At the time that this occurs, a change may frequently be observed in the character of the original sore; a fresh effusion of lymph may take place in its neighbourhood, or the sore itself may ulcerate in a way that it did not before. The nature of the sore will now become altered—a free secretion of pus will often take place from its surface. It no longer presents the characters of the adhesive inflammation only. It has, in fact, become one of the secondary symptoms of the disease. The inguinal glands, in like manner, which up to this period were indurated and enlarged only, will now sometimes show signs of increased morbid action. They may become tender to the touch. The thickening, originally confined to the glands themselves, may involve the surrounding cellular tissue; and it sometimes happens that an abscess will form either in one of the glands, or in the surrounding structures. These suppurating buboes are to be regarded as a part of the secondary symptoms; and their occurrence in no way invalidates the fact previously dwelt upon, viz. that the sores which produce syphilitic infection of the constitution do not produce suppurating buboes, excepting from some accidental cause.

SYPHILITIC ERUPTIONS.

Roseola, the eruption which generally first succeeds the syphilitic fever, is of a rose-red colour, not raised above the surface of the skin; disappearing upon pressure, and returning as soon as the pressure is removed. It appears in more or less rounded patches, giving a mottled appearance to the skin; when examined closely, each patch

appears made up of a cluster of papillæ, more injected than natural. This eruption will sometimes disappear within a few days. If it persists, the papillæ forming each patch will generally become visibly enlarged, and the colour of the eruption will gradually change to a copper tint. This colour is a common characteristic of all syphilitic eruptions which remain for any length of time without suppuration or ulceration.

The syphilitic eruptions which follow this first efflorescence on the skin present a variety of appearances.

Lichen.—The papillæ of the skin frequently are enlarged separately and scattered irregularly over the body. They form small hard elevations of a copper colour, which terminate by desquamation or resolution. The enlarged papillæ are sometimes formed into groups, and then, occasionally, one much larger than the rest appears as a tubercle in the centre. This form of eruption has been described separately as *central tubercle*.

Syphilitic tubercle.—The same tendency, which has been traced throughout to the exudation of a fibrinous or plastic material from the diseased blood, manifests itself particularly in this form of disease. The effusion takes place by a slow, gradual, and uninterrupted process, and becomes perfectly organised as in the papular eruption; each tubercle appears as a small, full, and tense conical eminence, covered with a red and shining cuticle, gradually, like other syphilitic eruptions, assuming a copper colour. The tubercles may be scattered singly over the surface, or they may be seen in groups.

The syphilitic tubercles may assume any size, from a large pimple to a split pea or bean. Their shape is generally round, but often they are irregularly oval. The cuticle thrown off from the surface of syphilitic tubercles is peculiarly thin, white, and shining. It resembles small broken pieces of silver paper. When syphilitic tubercles appear on mucous membranes, they are generally irregular in shape, flattened, and but slightly raised above the surface. These peculiarities depend in a great measure upon the mucous membrane from which they spring being opposed to other parts, and consequently subject to a certain amount of pressure. The tubercular form of eruption on the skin generally occurs at a later period than the other eruptions, which are accompanied by the adhesive form of inflammation.

Syphilitic lepra commences, like the mottled skin previously described, by the injection of circular groups of the papillæ of the skin. These may at first be seen separate, but soon the whole circular patch becomes equally involved; an effusion takes place into the substance of the skin, which causes a small flat elevation, the edges of which are sometimes raised higher than the centre. A large number of these patches, all nearly circular, may form on any part of the body. They have, like other syphilitic eruptions, more or less of a copper colour; but this is often partially masked by a thin layer of epithelium, which is thrown off in thin white and shining scales. Patches of syphilitic lepra sometimes bear a strong resemblance to flattened syphilitic tubercles.

Syphilitic psoriasis occurs in the form of oval or irregular patches slightly raised above the surface. These are generally of a brown or copper colour, and covered with epithelial scales of various degrees of thickness. They are not depressed in the centre, and are often traversed by cracks which show no tendency to become obliterated.

This disease is much more persistent in its character than syphilitic lepra. It is frequently observed on the palms of the hands and the soles of the feet, but it may occur on any part of the body. Patches of syphilitic psoriasis will sometimes remain for months without undergoing much alteration in appearance.

Syphilitic psoriasis is very liable to be confounded with ordinary psoriasis. Dr. Anderson has enumerated the distinguishing characters of syphilitic psoriasis under the following heads: It is not usually very extensive. It generally occurs as a second stage to some other syphilitic eruption. Some of the patches may be moist, or covered with crusts, or even in a state of ulceration. The patches are usually small and in the shape of round spots or circles or segments of circles. The eruption is not usually on the elbows or knees. It is more on the inner than on the outer sides of the limbs.

When confined to the soles of the feet or palms of the hands it is always syphilitic. The eruption in its chronic stage usually assumes a distinctly coppery tint. It often itches. It usually commences for the first time after twenty years of age.

The eruptions now described may be classed together as resulting from secondary adhesive inflammation; they are essentially of the same character, and require the same mode of treatment. Not unfrequently they will appear upon the patient at the same time, or will follow each other at successive periods. The tendency of these, as of other syphilitic eruptions, is to fade after a time, but to appear again and again, unless checked by treatment; after the disease has existed some time they have, however, a greater disposition to assume an ulcerative or suppurative form than to recur in their proper adhesive characters.

The same mode of treatment has been adopted generally for these eruptions as for the primary disease to which they owe their origin.

Mercury, in some form, is the remedy that alone can be relied upon. As in the primary infecting sore, it may be given internally, or may be used in the form of ointment rubbed on the skin, or may be administered as a mercurial vapour-bath.

In private practice it may be convenient to give mercury internally, on account of the little observation which this plan attracts, and the apparent ease with which it is followed. But, even with young men in the vigour of health, it will rarely happen that mercury can be taken sufficiently long in this way to cure the disease: at the end of perhaps two or three weeks the digestive organs become disturbed by the constant irritation of the medicine; an attack of diarrhoea perhaps supervenes, which may be checked for a time by opium; but if the internal administration of the mercury be continued, some other form of inconvenience will arise; and, practically, the remedy has to be given up, in the very great majority of cases, before the patient is cured. When the eruption occurs under these circumstances at a subsequent period, it presents often a more troublesome and worse form of disease than if no mercury had been given; the long-continued irritation of the patient's digestive organs has produced an effect upon his system, and the diseased as well as the healthy actions of the body are consequently performed with enfeebled powers, and a lower type of affections are produced. From these considerations, the use of mercury internally has for many years past been used very sparingly in the author's practice.

The inunction of mercurial ointment is a very efficient way of bringing a patient's system under the influence of the drug; and the action may in this way be continued for the requisite length of time, provided the laborious process which it entails, and the dirty condition in which it leaves the skin, are not objected to. In the treatment of cases of eruption on the skin it may, however, cause irritation in any of the spots upon which the ointment is rubbed, and may consequently have to be discontinued.

The mercurial vapour-bath is by far the least disagreeable mode of administering mercury: at the same time that it enables the surgeon to regulate the action of the medicine with the greatest nicety, it does not endanger the patient's powers nor produce irritation in any part of the skin. A full description of its mode of application will be given in a future chapter.

Iodide of potassium has very often been used for the papular, tubercular, and squamous syphilitic eruptions. From three to five grains are generally given in solution three times a day. This medicine certainly has a great power in removing syphilitic eruptions, and other forms of secondary and tertiary syphilis; but it does not, according to my experience, cure the disease. The symptoms disappear, the surgeon and the patient often congratulate themselves on the result, but within a few weeks the eruption appears again in the same or a somewhat different form.

Iodide of mercury is a very favourite medicine with many continental surgeons; a grain may be made into a pill and given three times a day, and this dose may be gradually increased to three grains.

Mercury given in this form is more easily eliminated from the system than when given alone, and it also produces a more visible and decided effect upon the patient's system.

The bromide of mercury has lately been recommended by Dr. P. Smith. It is given in the same doses as the iodide.

Iodide of potassium, or iodide of sodium, may be given internally, while the mercury is administered through the skin. These medicines probably then unite in the system, and produce much the same effect as if the iodide of mercury were given. This mode of giving the iodide of mercury has, however, the great advantage of saving the digestive organs and the liver from any irritation from the mercury.

Sarsaparilla, useful in some forms of tertiary syphilis, has very little, if any, influence over the eruptions under consideration. Mr. Bromfield, formerly surgeon to the Lock Hospital, in his practical observations, says, 'I solemnly declare I never saw a single instance in my life where it cured the disorder without the assistance of mercury.' Mr. Pearson's observations led him to the same conclusion. We are therefore led to believe, although sarsaparilla is often given, even at the present day, for papular, tubercular, and scaly eruptions on the skin, that these affections, when they appear to have been benefited by that medicine, have in reality either in their natural course undergone a change for the better, or have been relieved by other medicines given at the same time as the sarsaparilla.

One source, and a very common one, observes Mr. Pearson, to which some of the mistakes committed upon this subject may be traced, is a persuasion that every morbid alteration which arises in an infected person is actually tainted with the venereal virus, and ought to be ascribed to it as its real cause.

Every experienced surgeon must, however, be aware that very little truth or reality exists in a representation of this kind. The contagious matter and the mineral specific may jointly produce in certain habits of body a new series of symptoms, which, strictly speaking, are not venereal, which cannot be cured by mercury, and which sometimes are more to be dreaded than the simple and natural effects of the syphilitic virus. Some of the most formidable of these appearances may be sometimes removed by sarsaparilla, the syphilitic virus still remaining in the system; and when the force of that poison has been completely subdued by mercury, the same vegetable is also capable of freeing the patient from what may be called the sequelæ of a mercurial course.

Pustular syphilitic eruption.—When the syphilitic disease was recognised at the end of the fifteenth century, the eruptions which it produced were frequently described as pustular. No very accurate description of these so-called pustules is, however, given; and, considering the vague nomenclature of the day, it may appear doubtful whether these were not in reality vesicular eruptions, such as were observed in some of the fatal cases at Rivalta. Pustular syphilitic eruptions do occur, but they are very rare in unimpaired constitutions, as the first general eruption.

From constitutional causes, the primary disease which, in its normal course, and in a healthy constitution, would present the characters of the adhesive form of inflammation, may soon after its first appearance suppurate, become phagedænic, or, in a few exceptional cases, it may be accompanied by a suppurating bubo. So the secondary form of disease, which in a healthy person would produce one of the eruptions characterised by the adhesive form of inflammation, may suppurate, ulcerate, or become phagedænic.

The most common form of pustular syphilitic eruption arises from the transformation of one of the forms of the adhesive into the suppurative inflammation. A papular or tubercular eruption will appear in the first instance, and the plastic material effused will be completely organised; the patient may then have an imperfect or irregular course of mercury, or his health may be deteriorated from other causes, and the eruption will then reappear, and the summit of each spot will contain a material incapable of being organised, which will become more or less perfectly transformed into pus.

The proper syphilitic pustular eruptions are divided by Cazenave¹ into three kinds, which he describes as follows:—

1. In one form the pustules (*psyraceous*) are either small and narrow, or of a large size, elevated, and round. They have a hard base, and are surrounded by a

¹ *Manual of Diseases of the Skin*, by Burgess.

copper-coloured areola. The pustules themselves are of a dull reddish hue, and are developed in successive crops, presenting examples of the disease in its origin, maturity, and decline. Their progress is slow, and the inflammation attending them moderate; in some cases, however, it destroys the true skin, and leaves behind it a small white circular scar, depressed in the centre, and not larger than a pin's head. These scars, which have been erroneously supposed to follow papules, because the affection has been confounded with a papular eruption, are in a great majority of cases the sequels of true pustules. This form chiefly occurs on the face and forehead, where it bears some resemblance to acne rosacea; but it may appear on every part of the surface. The pustules dry off, and form a small greyish scab, which separates, and may leave behind it either a cicatrix or some injection of the skin. The pydraceous pustules rarely terminate in ulceration, and then only when several of them have become confluent.

When seated on the limbs, these pustules present a different appearance. They are sometimes of the size of a lentil, numerous, but slightly elevated above the surface, with a hard base, and contain a very small quantity of yellowish-white matter, which presents a strong contrast to the copper-coloured elevation on which it rests. They are not followed by ulcers; a thin scab forms on them, which is followed by a scar, or sometimes by a livid discoloration, or a small chronic induration.

This form of syphilitic eruption (called also *lenticular pustular eruption*) is the most common of all those which assume the pustular character, and is the one most frequently taken for the papular form; doubtless in consequence of the rapidity with which it passes into the purulent stage, and the persistence of the induration which so early follows, and also on account of the peculiar arrangement of the eruption, which is always spread over a large surface in isolated elevations.

2. *Syphilitic impetigo*.—This form is usually preceded by slight malaise, and commences with redness of the affected points; this is followed by small collections of purulent matter, forming irregularly shaped patches, more or less confluent, resting upon surfaces of a coppery-red colour, which are soon covered by scabs, irregular in shape, harder, darker coloured, and more adherent than those of common impetigo. Beneath these scabs are characteristic ulcerations, which are followed by scars, varying in extent and shape. This is the form called *pustulo crustaceous syphilitic eruption*. It may affect any part of the surface, but more frequently attacks the face. It sometimes appears on several places at the same time, but has no tendency to spread to neighbouring parts. It is always secondary.

3. In the third variety of syphilitic pustular eruption, the pustules are still larger (*ecthyma syphiliticum*), and resemble those of ecthyma. They are few in number, isolated, and chiefly occur on the limbs, and especially the legs. They appear at first in the form of a large livid spot, about the size of a shilling, or larger. The epidermis is now raised over a considerable portion of the spot, by a grayish, sero-purulent matter; the elevation increases slowly, and is always surrounded by a broad copper-coloured areola, quite different from that of ordinary ecthyma, which is of a violet-red. After a few days, the pustule breaks, and the contained matter concretes into a dark hard scab, which gradually becomes thicker, and fissured at the edges, being of a circular shape. All this occurs without any local inflammation; there is little heat, and no pain; the scabs are extremely tenacious, and may remain for an indefinite time without separating. When they do come away, we find underneath them deep round ulcers, with sharp-cut hard edges, of a purple colour, whilst the bottom is greyish and ill-looking. They have little tendency to spread. The scabs now gradually form again, and are frequently renewed, until, under the use of appropriate means, they become thinner, while the ulcers get clean and heal, leaving behind them circular and lasting cicatrices.

This is the most common form of the syphilitic pustular eruption, and the one which usually occurs in new-born children. Here the pustules are broad, superficial, flat, of an oval shape, and in great numbers; the scabs are dark and thick, and conceal small ulcers underneath. The countenance of the patient presents, at the

same time, a peculiar appearance, which it is difficult to describe : the skin is of an earthy hue ; the child is emaciated, the face is drawn in and marked, like that of an old person, by numerous wrinkles, while the whole body exhales a most disagreeable odour.

Treatment of pustular syphilitic eruptions.—It will, I believe, be found a universal rule in the treatment of both primary and secondary syphilis, that mercury will not agree with patients during the time that active suppuration, on however small a scale, is taking place. Other remedies have then to be sought : among these the iodide of potassium occupies the first place. This remedy may be given alone, or in combination with iron or other tonics. The usual dose is from three to five grains, three times a day, in solution. This medicine has a marked effect in removing the symptoms in almost every form of secondary syphilis. Practically this is a great advantage ; but it certainly does not cure the disease in the same way as mercury does, when that medicine is properly administered and can be conveniently borne.

Larger doses of the iodide of potassium are often given, as much as ten or fifteen grains three times a day ; and these sometimes succeed when the smaller doses have failed.

Guaiacum in the form of decoction was supposed, during two centuries, to possess anti-venereal properties ; and we are told by Mr. Pearson that its reputation was supported by well-attested narratives in a great number of instances where no mercury had been employed, or where that medicine had done no permanent good, or where the patients had suffered injury from it instead of finding advantage.

After a careful investigation of the properties of guaiacum, the following are Mr. Pearson's conclusions with regard to it : 'The decoction commonly excites a grateful sensation of warmth in the stomach ; it gives a sense of dryness to the mouth, and creates thirst ; it also increases the natural temperature of the skin, and renders the pulse more frequent. If the patient drink the decoction warm and lie in bed, it generally proves moderately sudorific ; and this effect may be heightened as much as we please by employing the hot bath, the vapour-bath, antimonials combined with opium, or the pulvis ipecacuanhæ compositus. When the decoction has been continued during ten or twelve days, in the quantity of four pints each day, the patient often complains of its producing the heartburn, accompanied with flatulence ; and he is usually costive during the whole course. If the person expose himself freely to the air while he is taking this medicine, the secretion of urine will be augmented, but no sensible alteration will take place in the state of the skin.

'When I have exhibited the decoction of guaiacum in pains of the bones, as they are called, confining the patient at the same time to bed, and enjoining a diet consisting of fluids only, I have rarely seen any beneficial consequences result from the use of it, except where it acted as a sudorific ; and in this respect I think its qualities manifestly inferior to antimony or volatile alkali. In several instances, after persisting in a course of it during four or five weeks, I have not gained any material advantage ; and I have remarked, that when the dolores osteocopi were not connected with some morbid alteration of the structure of a part, this medicine was of little avail. When the strength and vigour had been reduced by a successful mercurial course, with confinement to the house, and where a thickened state of the ligaments or of the periosteum remains, or where there are foul indolent ulcers, these sores will often heal, and the enlarged membranes will subside, during the administration of this decoction.

'The decoction of guaiacum will often suspend the progress of certain secondary symptoms of lues venerea for a short time, such as ulcers of the tonsils, venereal eruptions, and even nodes ; but I never saw one single instance in which the powers of this medicine eradicated the venereal virus. It has been recommended by many people to combine guaiacum with mercury, with the intention of improving the specific powers, and of counteracting the injurious effects, of that mineral ; the advantages to be derived from this compound mode of treatment are by no means well established, for guaiacum is certainly no antidote to syphilis.'

Mr. Pearson's opinion with regard to the virtues of sarsaparilla, founded as it was upon a very large experience and a great number of experiments, is perhaps as valuable and correct as can be obtained. 'While I reject it,' he says, 'as a specific, I would by no means disparage it as a medicine possessing no valuable qualities. In those cases where the malignant powers of the virus have proved materially prejudicial to the health, so that the patient cannot enter upon the use of mercury with propriety, the decoction and powder of sarsaparilla will often retard the destructive agency of the venereal poison, and repair the breaches made in the constitution; it may be sometimes given with advantage during a course of mercurial frictions, when it does not occasion a determination to the bowels; and it will almost invariably remove many of the most troublesome sequelæ of a course of mercury.'

Nor are the salutary properties of the sarsaparilla root useful in those diseases only that are either immediately or remotely connected with syphilis; its beneficial effects are often demonstrated in the treatment of foul, untractable, spreading sores in more than one form of scrofula.

In all diseases characterised by want of power, bark may be advantageously employed; and it may often be most beneficially used in cases of syphilitic eruption, where, either from some constitutional peculiarity, or from the long continuance of the disease, or from the debilitating effects of the remedies employed, a want of power is manifested in a patient's system. It may conveniently be given during a mercurial course, or after the mercury has been discontinued. The beneficial effects of bark are, however, most manifest in cases where destructive ulceration or sloughing occurs.

Opium is, next to mercury and the iodide of potassium, perhaps the most useful remedy in the treatment of venereal diseases; and with regard to it Mr. Pearson's opinion may again be taken. He says, 'An experience of nearly twenty years has taught me that when it is combined with mercury, the proper efficacy of the latter is not in any measure increased; that it would not be safe to rely upon a smaller quantity of the mineral specific, nor to contract the mercurial course within a shorter limit than where no opium has been employed.'

'This representation will not, I presume, admit of controversy: yet we frequently hear people expressing themselves upon this head, as if opium manifested some peculiar qualities, in venereal complaints, of a distinct nature from its well-known narcotic properties, and thus afforded an important aid to mercury in the removal of lues venerea. Perhaps it may not be unuseful to disentangle this subject from the perplexity in which such indefinite language necessarily involves it.'

'Opium, when given in conjunction with mercury, by diminishing the sensibility of the stomach and bowels, prevents many of those inconveniences which this mineral is apt to excite in the primæ viæ; and thus its admission into the general system is facilitated. Mercury will likewise often produce a morbid irritability, accompanied with restlessness and insomnolence; and it sometimes renders venereal sores painful and disposed to spread. These accidental evils, not necessarily connected with venereal disease, may be commonly alleviated, and often entirely removed, by a judicious administration of opium; and the patient will consequently be enabled to persist in using the mineral specific. It must, however, be perfectly obvious that opium, in conferring this sort of relief, communicates no additional virtues to mercury; and that in reality it assists the constitution of the patient, not the operation of the medicine with which it is combined.'

'The salutary effects of mercury as an antidote may be diminished, or lost, by the supervention of vomiting, dysentery, &c. Opium will often correct these morbid appearances, and so will spices, wine, an appropriate diet, &c.; yet it would be a strange use of words to urge, wherever these articles of food were beneficial to a venereal patient, that they concurred in augmenting the medicinal virtues of mercury. It may be supposed that the majority of medical men would understand by the terms, "to assist a medicine in curing a contagious disease," that the drug conjoined with the specific actually increased its medicinal efficacy; whereas, in the instances before us, it is the human body only which has been aided to resist the operation of certain

noxious powers, which would render a perseverance in the antidote prejudicial or impossible.

'The soothing qualities of this admirable medicine can scarcely be estimated too highly; yet we must beware of ascribing effects to them which have no existence; since a confidence in the anti-venereal virtues of opium would be a source of greater mischief than its most valuable properties would be able to compensate.'

SECONDARY SYPHILITIC VESICULAR ERUPTIONS.

From some peculiarity in the patient's constitution, or from some want of power in carrying out the natural processes of the disease, the syphilitic eruption may be accompanied by an effusion of serum only. The diseases thus produced have received a variety of names, according as they have resembled other diseases of the skin. Thus we have described *syphilitic herpes*, *syphilitic eczema*, the *varicelloid syphilitic eruption*, the *impetiginous syphilitic eczema*.

When the effusion of serum beneath the cuticle is larger, bullæ are formed instead of vesicles, and then the disease is described as syphilitic pemphigus. These all are only accidental modifications, and do not belong to the essential nature of the syphilitic disease. They may pass one into another, and be preceded or followed by other forms of eruption. They do not, consequently, require any separate and distinct mode of treatment.

SECONDARY SYPHILITIC ULCERATIONS.

About the period when a patient's constitution gives evidence of being affected with the syphilitic poison, the original primary chancre will often ulcerate in a way that it had not done before; at this period also, as the consequence of that ulceration, the corresponding lymphatic glands will become affected, and sometimes suppurate, as has already been explained. These ulcerations must be regarded as altogether of a secondary nature, and they are frequently healed with much difficulty. The secondary inflammation of the skin may, in like manner, in any situation terminate in ulceration; but this ulceration is generally not attended with suppuration of the corresponding lymphatic glands. The absorbent glands, which receive the lymphatics from the ulcers now under consideration, become often enlarged, especially at the back part of the neck; but they do not, as a rule, suppurate.

Large portions of the skin are often destroyed by these secondary ulcerations; and if they occur upon the face, they leave great disfigurement.

No remedy is so efficacious for these secondary ulcerations as the calomel vapour-bath. It generally happens, on account of the rapid progress of the ulceration in these cases, that it is advantageous to bring a patient's system rapidly under the influence of mercury; and then the general calomel-bath should be used every night, taking care to have the parts ulcerated as much exposed to the vapour of calomel as possible. But in cases where a general mercurial affection of the system is not desirable, a local fumigation will answer the purpose. Different plans are adopted for the local calomel fumigation; the only essential condition is, that the volatilised calomel should come in contact with the ulcerated surface, which it then covers in a state of most minute subdivision.

The ordinary fumigating-lamp, used without water, answers the purpose of local fumigation extremely well. Five or ten grains of calomel may be volatilised, and the ulcerated part should then be held directly over the lamp. The vapour of calomel ascends perpendicularly, and is deposited upon the first surface with which it comes in contact.

There is a form of ulceration in the skin of patients affected with secondary syphilis which does not depend upon the direct influence of the syphilitic poison, but which is extremely liable to be mistaken for those that do. The ulcerations now referred to generally occur where some portion of bone about the skull has

become affected, and where, either by direct irritation or by reflex action, the nerves going from the brain, or spinal cord, are kept in a chronic and persistent state of morbid irritability.

CASE.—Mr. —, a tradesman in the City, came under my observation on March 3, 1859. He gave no distinct history of any primary syphilitic affection, but a well-marked and accurately defined induration existed at the upper part of the root of the penis.

Eight years previously, an ulcer made its appearance on the forehead, immediately over the left eye. This spread rapidly in every direction: about the same time the skin over the right elbow began to ulcerate. This ulceration extended upwards and downwards, and involved the skin of the whole arm. The ulceration on the forehead healed, but that on the arm had never entirely done so. Three years after the commencement of this ulceration, he had a severe convulsive fit; he was not insensible, but there was violent contraction of the muscles of the jaw and back. During the continuance of the spasm no food could be administered. The muscles of the face were likewise affected.

In the year 1857, it became evident that the bones of the skull were extensively diseased. He was now one day suddenly seized with violent spasmodic contractions of the right side of the face, which lasted half an hour, without loss of consciousness. Four months later, a second attack followed, of a more severe character. This lasted six hours and a half, was accompanied by partial paralysis of the right side of the body, and tremor of the limbs. Subsequently to this, several milder attacks occurred, and increased in frequency. He always had a warning of these attacks. His face became flushed, there was a difficulty of articulation, and tremor of the muscles on the right side of the face.

This patient underwent a great variety of treatment by different medical men, and was, for a considerable period, out-patient at St. Bartholomew's Hospital. On September 13, 1859, he was admitted into the Lock Hospital; an ulcer still at that time existed on the outer side of the right forearm. The cicatrised skin from the shoulder to the wrist firmly bound down the parts beneath, and the arm was, in consequence, very much reduced in size. There was no motion either in the elbow or wrist joints. The hand was greatly swollen and oedematous. The frontal and parietal bones were in several places denuded. Extensive portions of their outer tables were either carious or necrosed.

All ordinary remedies having been previously exhausted, this patient was placed under the influence of chloroform, on October 25, and the trephine applied in several places over the right parietal bone. In the part apparently the most diseased, the whole thickness of the skull was removed, to the extent of one crown of the trephine. In other places, the outer and middle tables only were taken away. The exposed dura-mater, where the whole thickness of the skull had been removed, bled freely, and did not appear to be covered by any deposit. The surface of bone which lay in contact with it was slightly eroded, and was also perforated by numerous very minute holes.

October 26. Had slept well during the night.

November 5. Had two fits last night similar to those he had had previous to the operation. They were reported by the house-surgeon as 'of an epileptic character, accompanied by loss of voluntary power.'

November 12. General health improved. Healthy granulations from the scalp. The ulcer on the arm showed a disposition to heal.

November 27. Had a slight fit which lasted about a quarter of an hour. During this time he was quite conscious, but the lower jaw was fixed, and the muscles of the face were slightly convulsed. From this time until he left the hospital on December 23, there was no recurrence of the fits. The wounds in the scalp assumed a healthy aspect, although there were still some small portions of bone which remained uncovered. The wound in the arm became reduced to the size of a fourpenny-piece, and ultimately healed.

SECONDARY SYPHILITIC DISEASE OF MUCOUS MEMBRANES.

When a portion of mucous membrane becomes exposed for any length of time on the surface of the body, it gradually assumes the characters of skin, and becomes covered by cuticle. Secondary syphilitic eruptions here present the same characters as upon the true skin; but in the mucous membrane itself the appearances of these eruptions are necessarily modified. These membranes are little prone to the adhesive form of inflammation; and although they may be affected at the same time and from the same cause as the skin, yet the peculiar characteristics of the adhesive inflammation will not in them be generally fully developed. In those situations, however, where the mucous membrane joins the skin, and especially when from exposure and irritation it has become thickened and assumed the nature of skin, the different forms of syphilitic eruption will be well marked.

Every form of syphilitic affection of the skin has its counterpart on the mucous

membranes; but the appearances will be modified by the comparative thinness of the structure, by the absence of cuticle, and by the little disposition these parts have to take on the adhesive inflammation. There are some of these which require a particular notice.

Mucous tubercles correspond to tubercles upon the skin. They have generally a more extended base, with a flat surface, or the edges raised above the centre. Although dependent in their origin upon the adhesive form of inflammation, yet they soon suppurate, and so far lose their original character. Mucous tubercles are much more easily influenced by local treatment than tubercles on the skin. A solution of bichloride of mercury, one or two grains to the ounce, or some mercurial ointment, or calomel-powder, are very effective applications. These mucous tubercles affect the inside of the cheeks, the arches of the palate, the lips, the parts of generation, and the rectum. In the latter situation they are very likely to be mistaken for warts, from which, however, they ought carefully to be distinguished. Both may be communicated by impure contact; but the mucous tubercle is a secondary syphilitic affection, requiring constitutional treatment; the wart is a local disease, requiring only local applications.

Deep ulcer of the tonsils commences in general without producing pain or other inconvenience. The mucous membrane is of a livid red colour, and passes rapidly into a state of ulceration. The ulceration spreads, extending in every direction alike and often produces a deep circular ulcer with sharp edges. It has often a yellowish base; but this varies according to the nature of the secretion which adheres to it. This ulcer has been supposed to be particularly influenced by the bichloride of mercury given internally; an eighth of a grain may be given, in decoction or tincture of bark, three times a day.

The mucous membrane of the pharynx and larynx is liable to be affected in secondary syphilitic disease, the former probably more frequently than the latter; but on account of the importance of the parts concerned, the latter has been described separately under the name of *syphilitic laryngitis*. This disease is sometimes accompanied by a fixed pain on a level with the thyroid cartilage, and there is occasionally evident swelling externally; the voice, breathing, and deglutition may all be more or less interfered with. There is generally a hacking cough with attempts to expectorate, and some puriform matter streaked with blood is occasionally expelled.

If the disease continues, it is sometimes accompanied by emaciation, night-sweats, and dangerous exhaustion of the patient's system. Portions of the hyoid bone, or of the thyroid or cricoid cartilages, may be destroyed by this disease, and pieces of those cartilages have been known, when disengaged, to pass down the bronchi into the lungs.

Syphilitic iritis has been considered under the head of DISEASES OF THE EYE.

CHAPTER XI.

TERTIARY SYPHILIS.

In tertiary syphilis there is the same tendency to the effusion of a plastic material from the blood that we have traced throughout. Indolent nodules are formed in the skin, which very slowly desquamate, or ulcerate, or become phagedænic. In the cellular tissue circular deposits are formed, which after a considerable time become softened down. The skin over them breaks, and a ragged ulcer is left, with overhanging edges, the cellular tissue having been destroyed to a greater extent than the skin.

In the substance of the heart, in the liver and other internal organs, even in the structure of nerves, the same deposit may sometimes be found. These formations occur in irregular masses, often of a more or less circular form, and may remain probably without undergoing any material change for a very considerable period.

There is little doubt but that, under appropriate treatment, they may be entirely re-absorbed. These tubercles must be distinguished from the results of ordinary secondary inflammation, such as occur after surgical injuries and operations. But I believe that patients labouring under syphilis, even in its tertiary forms, are more liable to secondary deposits after surgical operations than others.

Tertiary syphilis, in one form or another, may probably affect every structure of the body; but the diseases thus produced so much resemble those that arise from other causes, that from the morbid changes alone, independently of the history of the case, it would often be impossible to recognise their true nature. A general description of some of the most important tertiary syphilitic affections will now be given.

Diseases of the skin and mucous membranes.—These consist mainly of ulcerations of a peculiarly unhealthy and persistent character, attacking various parts of the body, but chiefly portions of the face, nails, ears, and mucous membranes of the various openings of the body. In many instances no secondary affection of the part involved has preceded these ulcerations; whilst in others, and especially in those which are found on the face, the disease seems to consist of an extension of ulceration from a previously existing secondary sore. The parts of the face usually attacked are the nose and lips. A tubercular nodule is commonly first noticed. This becomes a hardened copper coloured mass, varying in diameter from the eighth of an inch and upwards. It often remains for many months without undergoing any material change, and then perhaps in some temporary depression of health it will break out suddenly into an open sore, and extend itself by rapid ulceration; or the ulceration may be more slow and gradual, eating, perhaps, through the cartilages of the nose, and reaching to its inner cavities, with more or less destruction of the sense of smell, and a decided change of voice. Occasionally the ulceration begins from within, and extends outwards, producing similar destruction of parts. If the ulcerative action should not be arrested, it may involve the deeper structures, attacking the bones of the nose and all the parts in its neighbourhood, and completely destroying the sense of smell.

The disease of the lips commonly begins with a few cracks in either lip, which, like the preceding, may remain for weeks or months, and then ulcerate extensively.

Onychia.—The parts about the nails are liable to similar ulcerations. That most generally observed is an ulceration of the root of the nail, of an obstinate and unhealthy nature, of a dark, almost black, colour, and surrounded by a deep copper-red margin. It is a form of onychia extremely difficult to eradicate, as the ulceration is very apt to return. It occurs either on the fingers or toes, though most commonly on the former. Ulcerations also frequently occur between the toes, and are characterised by a very offensive discharge. The best treatment for syphilitic onychia is to scrape the nail quite thin; rub it with nitrate of silver, and wait until it separates. At the same time a lotion of nitrate of silver should be applied constantly, by which the extremity of finger or toe becomes black, hardened, and little sensitive. Sometimes the nail can be easily separated in this way. If not, it must be enucleated, and it is the shortest course to remove the fold from which the nail springs, or destroy it by caustic; otherwise there is sure to be a reproduction of it. Lotions of liquor sodæ chlorinatæ are very useful, followed by red oxide of mercury ointment, or by the application of a solution of nitrate of silver. It is essential, in most cases, that the patient should take mercury; and local calomel fumigation has been found useful. When the nutrition of the skin is affected, the bulbs of the hairs are involved. The hair, being imperfectly nourished, becomes cracked, dry, and split at its extremities. It often breaks off short at the roots, and comes away in considerable quantities in the comb. When the bulbs are much diseased, the hair is not reproduced, and partial or even entire baldness is the result. This has been called *alopecia*. It may affect the beard, the eyebrows, and eyelashes. A case is recorded by Vidal where it was complete, causing total loss of hair over the whole body.

The mucous membranes most liable to attacks of tertiary syphilitic ulceration are those covering the tongue, gums, rectum, vagina, and os uteri. There is nothing

remarkable about the two former, except that, as the parts are more freely supplied with blood, the action is apt to be more energetic and rapid than in other cases. Accordingly ulcerations of the tongue are often seen of large size, even soon after it has become affected.

When the gums are diseased, the teeth frequently become involved and lost.

Diseases of the teeth.—The following remarkable and highly interesting case is taken from Dr. Marston's most valuable paper in the forty-fifth volume of the 'Medico-Chirurgical Transactions':—

Gr. D. C., aged 28. Upon April 23, 1856, this man had connection. Upon May 18 following he was admitted into hospital with a glandular swelling in each groin. He discovered afterwards that two soldiers had caught a venereal affection from the same woman. There were many glands affected in both groins, and one upon the left side inflamed and threatened suppuration, and was opened by caustic potash. Subsequently, an abscess appeared in the right groin, and was similarly treated. No sore of any kind existed on the penis, nor was there any urethral discharge, or cicatrix, or mark on the penis. Six weeks afterwards he suffered from a red rash over the whole body, and the skin came off in scales. This exanthem was followed by the appearance of numerous pustules and iritis of the right eye. For these symptoms he was treated by mercurials for a fortnight, but his mouth was not affected. He subsequently took large quantities of iodides in the decoct. sarsæ. comp. At the end of two months he was discharged cured (?). About seven or ten days afterwards he was re-admitted with 'rheumatism in all his bones,' particularly the legs. The rheumatism prevented him sleeping at night. After about four months' further treatment he was discharged cured, but he has never enjoyed the health he had before these attacks.

In the beginning of 1858, his teeth began to decay in the most curious manner. A dark spot would first appear upon the front aspect of the enamel, close to the gum. The lateral incisors of the upper jaw were first affected, and disease of the remaining front teeth speedily followed. This discoloured spot became the seat of caries, and a minute circular hole resulted, situated in the middle line of the tooth, bordering upon the gum. The disease in each tooth gradually advanced from before backwards, extending laterally at the same time, and making its way in a very definite manner, until the line of caries passed through the tooth, and severed it at its junction with the fang. He has lost the upper teeth in this way. The two central incisors, however, are not quite destroyed; the disease in these has nearly severed the crown from the fang. The lower teeth have commenced to be affected in a similar manner. A line of caries has appeared upon the incisor and canine teeth, exactly at the junction of the crown and fang and threatens their destruction.

Dr. Marston informs me that he has seen this very peculiar disease of the teeth follow the same course in two other cases. He directs attention to an interesting paper, read June 25, 1862, by Dr. Roberts of Manchester, upon two cases of double facial paralysis, apparently due to syphilitic disease, wherein there was a curious destruction of the teeth, and he refers to a similar case by the late Dr. Todd, in his volume of 'Clinical Lectures upon Nervous Diseases.'

Diseases of periosteum, bones, and joints.—Perhaps the most important of all these tertiary affections are those which attack the bones and their coverings.

They may be included under the heads of periostitis, acute and chronic; nodes and exostoses; inflammation of bone; caries and necrosis.

Acute periostitis is a rather rare result of syphilis; but when it occurs it is apt to be extensive and destructive. Chronic periostitis is very common. It is attended with great pain at night, and aching at every change of temperature or weather.

The interior as well as the surface of bones may be affected. The cancellous structure becomes thickened, condensed, and often much harder than natural. Fixed and long-continued pain in the bone, without much tenderness of its surface, may characterise this condition. The pain appears to arise from the pressure produced by the increased formation of bone, and is relieved, often permanently, by making an opening through the crust of the bone with a trephine. No fluid is found in the interior of the bone on these occasions.

Caries and necrosis of bone occur as tertiary forms of syphilis in the same parts as from other causes; the former in the cancellous structure, and the latter in the shafts of long bones or the dense parts of others. Necrosis is generally the result of acute periostitis. Caries is almost always produced by an extension of ulcerative action from soft parts to the bones. Thus, the bones of the ear are often affected by ulceration of the cartilage or lining membrane of the meatus; the bones of the

palate, from ulceration of the mucous membrane lining it; the bones of joints, from ulceration of the surrounding soft structures. It is very rare for caries to begin as a primary disease, at least in tertiary syphilis. During this ulceration of bone, serious destruction may take place. Joints may be disintegrated, the organs of hearing lost, or the bones of the nose or palate destroyed. The bones of the skull are usually affected in their outer and middle tables only. The diploë becomes filled with bony matter, and then ulcerates or dies. Sometimes, although rarely, the inner table is affected to a greater extent than the outer or middle. Effusion may then take place between the bone and dura mater, and the disease may extend by continuity of action to the brain. The brain may then become affected with red softening, and a part of it be ultimately softened down to the consistence of cream. In these cases it is the surface of the brain which is primarily affected; but in some cases the brain is affected independently of the bones, and some of the central portions, such as the corpora striata, are found softened.

Syphilitic orchitis will be more fully described in the essay on DISEASES OF THE MALE ORGANS. The course of the disease is remarkably slow and indolent, lasting for years, unless remedies have been applied; sometimes, as Dr. Wilks has well pointed out, the testicle may atrophy, from absorption of the effused material, and come to resemble a form of cirrhosis—as a firm alveolated-looking fibroid tissue, from the shrinking of the organ, the thickening of the tunica albuginea, the disposition of the atrophied remains of the spermatic ducts, and the fibrous processes from the fibrous investment. The sexual desires are not changed, unless in very chronic cases, or when the state last described has affected both organs.

The deposit usually occurs in the body of the testicle. Circular nodules of a yellowish-white material may be found dispersed through the substance of the organ or collected in one mass. At other times, according to Lancereaux, radiating bands of a tendinous appearance, starting from the thickened tunica albuginea, traverse a part or the whole of the thickness of the organ, insinuate themselves between the seminiferous canaliculi, and compress and separate them one from the other. The organ may then undergo a true fibro-fatty change.

Dr. Lancereaux has, under the head of ‘gummy deposits,’ given a description of syphilitic affections of a great variety of internal organs. The deposits which he describes are sometimes extensive and comparable to the chronic phlegmasiæ; sometimes limited and circumscribed. These deposits appear in the form of nodules or tubercles, and it is to this condition that the term ‘gummy tumour’ is particularly applied. Dr. Wilks has also given an admirable description of them as they occur in the muscles, in the lungs, liver, and spleen, in different parts of the nervous system, and in other internal organs. The limits of this essay preclude the possibility of tracing here the peculiarities which syphilitic disease presents in these different parts.

The absorbent glands are very frequently enlarged in tertiary syphilis. The condition of those situated in the upper and back part of the neck has, by many eminent writers, been regarded as diagnostic of a patient's system being affected with syphilis, or otherwise. But the absorbent glands are generally only affected in secondary and tertiary syphilis, in consequence of disease in the parts from whence they receive their vessels. It very frequently indeed happens, in secondary syphilis, that there is a sore upon some part of the head, and then the posterior cervical glands will in consequence be enlarged; but if the sore be confined to one side only (as, for instance, a chronic ulceration on one cheek), then the cervical glands will be enlarged on that side only.

TREATMENT OF TERTIARY SYPHILIS.

The same general remedies are used for this so-called tertiary as for the secondary forms of syphilis. Patients labouring under tertiary syphilis have, however, often undergone more than one course of mercury, imperfectly administered perhaps, or the effects of which may have been ill-regulated. In the great majority of cases, any further prolonged exhibition of mercury internally is out of the question.

Iodide of potassium, sarsaparilla, bark, the mineral acids, and opium, are therefore the remedies most generally used. The iodide of potassium is an excellent remedy in many forms of tertiary syphilitic ulceration, in cases of enlarged glands, and in syphilitic affections of the bones. From three to five grains of this medicine three times a day will seldom fail to relieve the pain of a syphilitic node within a few days.

The benefits of sarsaparilla are most marked in those cases in which the patient's constitution has been debilitated by the abuse of mercury, or where the bones have become affected with caries. In order, however, to obtain the remedial effects of this medicine, it should be given in sufficient quantity; a pint of the decoction should be given daily, or half an ounce of the fluid extract three times a day, and continued for some weeks. The iodide of potassium may very conveniently be combined with any of the preparations of sarsaparilla. Bark, iron, and the mineral acids are all of use in restoring the strength of the patient, impaired either by the disease, or by the injudicious use of remedies; and opium, by relieving pain and giving rest, will often prove most useful. But none of the medicines now mentioned will cure syphilis. Every form of this disease may ultimately be cured by the unassisted powers of nature, and the remedies above mentioned may render much assistance; and some of them, especially the iodide of potassium, have great influence in removing particular symptoms, but they do not cure the disease. The only medicine which can be considered as doing this is mercury; but in the tertiary forms of disease this medicine can scarcely be administered internally, and inunction is apt to be followed by troublesome pustules and ulcerations. Where other means fail, the slow imbibition of calomel through the skin affords an excellent means of introducing the medicine into a patient's constitution. If this remedy be really indicated, there is scarcely any condition in which it may not be used. In consequence of not interfering with the internal organs, it does not in any way increase the weakness under which the patient may be suffering, and may be given as a patient lies in bed. A large class of cases, in which a few years ago mercury was thought altogether inadmissible, are now habitually and effectually treated in this way. In the treatment of tertiary syphilis, the action required is less than in the secondary forms of the disease, but it should be maintained for an equal length of time. Ten grains of calomel, used with the fumigating-lamp, as described in the next chapter, are often sufficient; and if there are any open sores, still less may sometimes be used. Any of the usual tonics may of course be administered internally, at the same time that the patient is using mercurial fumigation. If the patient suffers much from perspiration, the calomel may be volatilised with a slight flame without any water. In this way any increase of debility in consequence of the sweating will be avoided. In cases where a patient's constitution has not been impaired, other forms of mercury may occasionally be used.

Some of these have been thought to be peculiarly adapted to one kind of affection, and some to another. Thus, for iritis calomel has generally been given internally, combined with opium. For the deep ulcer of the tonsils the bichloride of mercury has very often been described; and for eruptions on the skin the proto-iodide of mercury has been most extensively employed. But, generally speaking, whatever may be done with these remedies may also be effected by the imbibition of mercury through the skin; and the adoption of this mode of treatment, when properly carried out, is attended with a great saving of the powers of the patient's constitution.

CHAPTER XII.

ADMINISTRATION OF MERCURY.

THREE different ways of giving mercury have been recommended: 1. The administration of the medicine internally. 2. Its introduction into the patient's system through the skin, by means of mercurial frictions. 3. The use of mercurial vapour baths.

1. The blue pill is one of the most ordinary forms in which mercury is given. From three to five grains, combined with half a grain or a grain of opium, may be ordered two or three times a day. The *hydrargyrum cum cretâ* may be given in doses of from three to five grains, either alone or with an equal quantity of Dover's powder.

Calomel, either alone or mixed with opium, or in the form of the red pill, may also be given in doses of from one to three grains two or three times a day. All these preparations of mercury, as well as those which have been previously mentioned, are very valuable remedies under certain circumstances. But where a sustained and continued action is required they are very apt to produce irritation of the digestive organs. Even when combined with opium, the internal use of mercury can seldom be continued as long as is desirable. It will be found in some way or other to affect the patients' constitutions injuriously, and to make it extremely distasteful for them to continue the course for a proper and necessary time.

Mercury introduced into the stomach and intestines produces, as is well known, a powerful effect upon the liver. This doubtless depends upon the blood from these parts being directly conveyed through the *vena portæ* to that organ. Sir Ranald Martin, in his admirable work on the influence of tropical climates, observes that mercury enters into intimate union with the elements of the blood, and that it must therefore modify its plasticity, and influence all the organic functions to which it is subservient. The parts upon which this influence expends itself, when mercury is given internally, are the liver¹ and intestines. Even robust and healthy persons can seldom bear any prolonged irritation of these organs with impunity; and in patients of relaxed enfeebled habits, any sustained mercurial action which produces its primary and direct influence upon those parts is quite out of the question as a remedial measure.

2. Mercurial inunction is a very efficient way of using mercury; but is dirty, laborious, and often little suited to the taste of those who require its use. On this account, patients very frequently apply the remedy with great irregularity or even omit it altogether. It is, however, much less liable to produce griping and purging than when the drug is given internally, and the effect upon the constitution is not nearly so debilitating. When mercurial ointment is used, half a drachm or a drachm is rubbed into the inside of the thighs by the patient every night. This in winter is conveniently done before a fire. The ointment should be rubbed in until it disappears. The process will occupy about half an hour, and the patient should wear some flannel drawers, and not wash the remains of the ointment off. The application of the ointment must be repeated every night until the gums become soft and slightly spongy; this is the best indication of the proper action of mercury upon the patient's system, and the action should be maintained by regulating the quantity of ointment used, for six, seven, or eight weeks, according to circumstances. Many surgeons are in the habit of leaving off the mercury soon after the patient's gums are affected. According to the author's experience, this practice not only fails to cure the disease, but actually does harm. The patient's constitution is weakened to a certain extent, and the disease is not cured; but what is of more importance still is, that the secondary symptoms, when they do appear, are often of a worse and more intractable character than if no mercury had been given.

There are two principal objects in view in treating a case of syphilis: the first is to remove the symptoms, and the second to cure the disease. Now a short course of mercury will often effect the former of these two objects, as will also, in almost all secondary cases, the iodide of potassium; but neither the short course of mercury nor the iodide of potassium will in general cure syphilis. The symptoms will, it is true, be removed, but they will return; and practically it is found extremely difficult to induce patients, particularly in the upper classes of society, to continue a course

¹ A case has recently fallen under my observation in which a young gentleman, after the prolonged use of mercury internally, died of jaundice, to the surprise of all his friends.

of mercurial inunction sufficiently long to prevent the occurrence or the return of secondary syphilis.

By introducing mercury into a patient's constitution by inunction, its deleterious action upon internal organs is avoided. The amount absorbed into the blood produces its influence equally throughout the system, and is not conveyed direct to the liver, as when the medicine is administered internally.

But great as the advantages of the inunction of mercury are as compared with its internal administration, it nevertheless is attended with certain inconveniences which prevent its very general use. The inunction of mercurial ointment, so as to insure the proper effect of the remedy, requires considerable labour and perseverance on the part of the patients, and it is with difficulty that they can be induced to continue its use for any length of time; and sometimes it produces a troublesome pustular eruption on the skin.

3. Fumigation of the surface of the body by means of certain mercurial preparations possesses the advantages of inunction, without some of the objections to which this is liable. But, like other modes of using mercury, it was tried in a variety of ways before a safe and efficient mode of administration was adopted.

In the years 1786-7, Mr. Pearson had a fumigating machine constructed according to the directions given by M. Lalouette. This apparatus, although it was thought to be new at the time, differed in no material respect from that described by Nicholas de Blegny in the year 1683.

Mr. Pearson made a considerable number of experiments with this fumigating machine, and found that the gums became turgid and tender very quickly, and that the local appearances were sooner removed than by the other modes of introducing mercury into the system. But, to counterbalance these advantages, it was found that the mode of treatment adopted induced debility, and that pyalism was often excited rapidly, and at an early period. Mr. Pearson found that he was consequently obliged often to discontinue his course of treatment.

Sir Benjamin Brodie's experience coincided with that of Mr. Pearson. He found that it was difficult to regulate the mercurial action; and he observes that by using mercurial fumigation, 'you may affect the system too much or too little; and you may be taken unawares by the patient's gums becoming all at once excessively sore.'¹

From observations and comparative experiments which I made during the years 1855-6, I feel satisfied that the irregular results noticed by Mr. Pearson and Sir Benjamin Brodie depended upon the difference in the chemical composition of the powder used for the purposes of fumigation, both before and after it was raised into a state of vapour. The grey oxide of mercury (the preparation generally used) varies much in colour as obtained at different shops. Some specimens will not volatilise at the temperature produced by an ordinary spirit-lamp under a metallic plate. Other specimens of a lighter colour volatilise quickly enough. When the darker specimens are sublimed, they are decomposed in a greater or less degree. A deutoxide of mercury is formed by the addition of an equivalent of oxygen from the air; and if the temperature be much increased, then the oxygen is driven off altogether, and metallic mercury is sublimed. Under these circumstances, with a mercurial preparation of uncertain composition and undergoing different changes according to the degree of heat applied, there is no wonder that very different effects should have been produced in different cases. With some samples of the grey oxide it is necessary to use a considerable quantity of the powder in order to ensure any effect; with other samples, a similar quantity produces much more action than is desirable. The grey colour of the powder depends upon the admixture of a certain proportion of calomel with the protoxide, and the temperature at which any particular specimen will volatilise will depend upon the relative proportions of the two. The bisulphuret of mercury, again, which has been extensively used for the purposes of fumigation, gives off, when exposed to heat, a vapour, probably the sulphurous acid gas, which has sometimes caused very consider-

¹ *Lectures on Pathology and Surgery*, p. 246.

able irritation of the lungs; and all forms of mercurial fumigation have, in consequence, by some, been condemned.

Now, all the inconveniences above-mentioned may be avoided with certainty by using a mercurial preparation which is always of the same chemical composition, which does not irritate the lungs, and which is not liable to be altered by an increase of temperature. Such a preparation is calomel. We have here a definite chemical compound. It is altered in composition neither by heat nor by moisture, and when used for the purposes of general fumigation may be relied upon to produce its action as certainly as any medicine administered internally. A very small quantity (as compared with the other mercurial preparations) will ensure the required effect, and this may be regulated and controlled with great precision.

General calomel fumigation may be used in cases where the administration of mercury by other methods is inadmissible. On account of the small amount of calomel required, it may be used sometimes with the greatest benefit, even where other modes of fumigation, requiring larger quantities of mercury, cannot be borne.

Calomel appears to have been formerly used for the purposes of general fumigation, as well as other preparations of mercury. But it was used in the same quantities as those other preparations, and was therefore open to some of the same objections as they are.

M. Rapou published in Paris, in 1824, two volumes on Fumigations as employed in various diseases. The mercurial preparations which he recommended were cinnabar, Lalouette's mercurial powder (which consisted of a mixture of mercury and clay), calomel, and corrosive sublimate.

The quantity used for the first three he recommended to be from 'a quarter to half an ounce each time.' The amount of the corrosive sublimate, he says, should not exceed five or six grains.

Even with these very large quantities, M. Rapou had only seen salivation produced in three instances, and these were of a very short continuance, and yielded to the use of ordinary baths. M. Rapou recommended the mercurial fumigations to be used with steam, which, he said, calmed the system, softened the skin, and did not prevent the absorption of the mercury.

Mr. Langston Parker recommends an apparatus, for the use of which the patient is placed on a chair, and covered with an oil-cloth lined with flannel, which is supported by a proper framework. Under the chair are placed a copper bath containing from half a pint to a pint of water, and a tinned iron plate, on which is put from one to three drachms of the bisulphuret of mercury, or the same quantity of the grey oxide, or the binocide, or other mercurial preparation; under each of these is a spirit-lamp.

Now, all the methods of applying mercurial fumigation above mentioned require the use of a complicated apparatus, which private individuals cannot command. In order to adapt this method to general use, it was necessary so to modify the apparatus that anyone could use it in his own room; and this has now been most effectually accomplished.

The plan which I have usually adopted is as follows: A lamp, in which the methylated spirits of wine is burned, is put into a case, made principally of wire-gauze, on the principle of the Davy safety-lamp. The top of the case is fitted with a central, movable, small circular plate, surrounded by a trough made of porcelain, which should contain one ounce of water only. The water should be boiling when first put in, or should be allowed to remain over the lighted lamp until it begins to boil. Thirty grains of resublimed calomel are then spread out on the central small circular plate. This should be quite dry. The patient then sits, without his clothes, on a small stool or chair, and the lamp is placed between his legs. A cloak made of

moleskin or some thick material is then made to cover the whole apparatus, and is tied round the patient's neck. It is important that the cloak should go quite down to the ground all the way round. As the water boils a certain quantity of steam is

FIG. 82.



enclosed within the cloak; and, a little later, the vapour of the calomel as it rises passes through the steam and becomes mixed with it. The water first disappears, and the calomel is sublimed in from ten to fifteen minutes. The patient then gets into bed with the cloak on, so as to make it his night-dress. In this way the calomel is necessarily kept on the surface of the skin. The cloak used is furnished with a cane hoop, so as to be kept away from the skin during the action of the bath, and this hoop may be removed as soon as the bath is over, and replaced again before the bath is used the next night.¹ The cloak has a slit in front, which the patient is generally directed to open for about an inch, so as to allow some of the vapour to escape. This rises in front of his mouth and nose, and he is directed to inhale it for a minute at the expiration of each five, during the continuance of the bath, so as to breathe the vapour for about three minutes altogether. The patient during this time keeps his head up, so that the moistened calomel vapour passes for about six inches through the common air before it is inhaled. This inhalation is not always necessary, but it furnishes a means of regulating with the greatest nicety the action of the mercury, as indicated by its effects upon the gums. I have never found mercury administered in this way produce salivation where patients had not also taken it in some other form. The action is upon the surface of the body, and the internal parts are comparatively unaffected. No diarrhoea is produced except from some accidental cause. The stomach and intestines are not irritated, and are free for the use of food or medicine. The perspiration produced should amount only to a slight moisture on the skin, and when this is the case the patient very rarely experiences any debilitating effects from the continued use of the bath. During this treatment I generally recommend patients to abstain from taking vegetable acids; and for this purpose, as a rule, they are told not to eat raw vegetables or raw fruits, such as salads, cucumbers, celery, apples, pears, and oranges. As the object is to have the calomel in contact with the skin, the patient washes only as much as may be necessary. Boerhaave long ago made the observation, that if patients went about their usual occupation, and followed their usual pleasures, he could not cure them; and Pearson, as has been stated, found that, under any plan of treatment, if the patients were much exposed to cold air the effect of his remedies was materially interfered with. This will be the case with regard to any plan of treatment by which there is a fair prospect of really curing the disease. I know how often it has been asserted that the disease is not cured; but a long experience now enables me to say very positively, as I have before remarked, that numbers of patients, after having gone through a proper course of treatment, pass five, ten, fifteen, or twenty years without any fresh manifestations. They believe themselves to be cured, and whatever impression may be left upon their constitutions, no inconvenience subsequently arises either to themselves or their families. In this sense, then, syphilis may be cured, as well as any other recurrent fever to which the human body is liable.

But to effect this, as I have intimated, with any degree of certainty, the action of the medicine should not be interfered with by a diet that is likely to produce diarrhoea, or by exposure to fresh air or cold water. Fresh air has long been known as the antidote to mercurial action, and dabbling in water, either hot or cold, not only washes the calomel off the skin, but its evaporation chills the surface of the body, and certainly, according to my experience, prevents the full action of the bath as I have described it.

If a patient wants a wash, he may have, two or three times a week, a warm bath, and remain under the water as long as he pleases. There is then no evaporation from his skin, and he should dry himself as quickly as may be when his warm bath is finished. These are matters of minute detail, but upon their observance, or otherwise, the success of the treatment of many a case will depend. During the first period of treatment I generally recommend a patient not to be in the open air more than an hour a day, and to select the best part of the day for the purpose, but I seldom object to his going about any ordinary indoor occupation. When the

¹ The best apparatus hitherto made for the purpose of general fumigation is sold by Mr. Lowe of Stafford Street.

mercurial action is once established, and towards the end of the course, a greater degree of liberty may be allowed. The effect produced is usually a slight feeling in the gums, some increase of saliva, and a kind of metallic taste in the mouth. The gums sometimes become red and swollen, and some pain is experienced in biting a hard crust. All the beneficial effects of mercurial treatment may be obtained by the amount of action indicated by these symptoms, and I seldom, if ever, produce more. The time required for a mercurial course is a question of much interest and importance. This will necessarily vary, according to the nature of the case. It has before been shown that the manifestations of syphilis vary very much at its different periods, and that the disease is modified in a very important degree when it recurs. Under these varying conditions the mercurial treatment must be varied also, but there is no phase of syphilitic disease, in my opinion, to which it is not applicable.

In the forms of the disease affecting the skin, and characterised by the adhesive inflammation, whether primary or secondary, patients will bear well any form of mercurial treatment, at least for a time. If we have syphilis alone to deal with, at whatever period after affection, the disease is one, and the treatment the same. If the patient is of a strumous constitution; if he has previously been debilitated by prolonged, irregular, or injudicious courses of mercury; if he has suffered from ague, or some other form of fever; or if he has had disease of the liver, spleen, or some other internal organ, then mercury, whether in what have been called the primary or secondary forms of syphilis, must be administered with caution.

Mr. Pearson found that rather a shorter course of mercury was required for primary syphilis than for secondary. I have found, on the other hand, that a longer course is required for primary than for secondary disease. It is probable that as the diagnosis between real syphilis and local forms of the venereal disease was not made with the same accuracy in Mr. Pearson's time as at present, some cases that were not really syphilitic were included among those who were treated with mercury. These would for the most part get well rapidly, and would reduce the average time during which the treatment was continued. It would, however, be a great mistake to suppose, although no accurate account was then published with regard to affections which would, and those which would not, be followed by constitutional disease, that therefore the older surgeons had not the practical tact of at least distinguishing some of these.

In spite, however, of the difficulty which formerly existed, and still exists, with some surgeons, of distinguishing an infecting from a non-infecting sore, I am firmly of opinion that the older surgeons did not give mercury in the indiscriminate way that has been supposed; but still that they did give it in some cases where it was not necessary, and that the average period during which it should be continued for primary syphilis was therefore made to appear much shorter than at present. Another point which was not formerly accurately considered, has tended to the same result—viz. there is seldom a distinction drawn in the writings of the older surgeons between a disease treated for the first time and one which had recurred in a modified form. The latter would be very much more easily dealt with, and require a much shorter period of treatment.

For primary syphilis occurring in a patient for the first time, uninfluenced by the existence of previous disease in himself, or by hereditary influences of the same kind, I seldom now discontinue the treatment under three months, and I generally explain to the patient, to begin with, that unless he is prepared to follow such a course he had better wait until the secondary symptoms appear, and then undergo his treatment. It is often difficult to persuade a patient who has a slight induration, accompanied by the existence of amygdaloid glands, that his affection is of a nature to require such a course. He will probably ask some friend before he consents, and not unfrequently it has happened in my experience that he has been told that it is 'nothing,' and has waited until he has become practically convinced of the truth of the diagnosis. This occurred in the celebrated case of the late Mr. Wyndham, which I need not mind alluding to, as the facts were published over and over again in the daily papers. I told him that he not only had the disease, but that he might communicate it. He

replied, 'Well! I am told it is not so.' I did my best to persuade him, but in vain, and, as was soon after given in evidence, he infected his wife. When a patient consents to undergo a proper course of treatment, I generally make him take a calomel bath in the way I have described every night.

Some slight evidence of mercurial action generally appears on the gums within the first week, and this is steadily maintained either by the calomel bath alone, or by the addition of some other medicine. After this action has been kept up for seven or eight weeks, the patient is allowed more liberty, but the mercurial action is never allowed entirely to subside, and no break in the treatment is permitted. If the action of the mercury once entirely goes off, it is exceedingly difficult to establish it again in a satisfactory manner. Should this be attempted by increasing the quantity of mercury, the action reproduced will probably not be of the same satisfactory kind. The gums, instead of becoming slightly spongy and soft, will perhaps ulcerate, and there will be some general disturbance of the patient's system. In the treatment of a primary affection, all induration at the site of the original disease should disappear, and, if possible, the amygdaloid condition of the glands. This last, however, is an effect which it is sometimes exceedingly difficult to produce, and some enlargement of the inguinal glands will occasionally remain, in spite of any treatment, for some years, but often without any other manifestation of the disease.

In all secondary forms of skin disease characterised by the adhesive form of inflammation, the same mode of treatment may be pursued, in combination perhaps with some other medicines.

Of all the modes of administering mercury, fumigation is that which is attended with the least demand upon the patient's constitution. The amount administered in this way can be regulated with the greatest facility; and the action may be maintained without inconvenience for almost any length of time. On this account, as well as for other reasons, fumigation is, in my opinion, less liable to be followed by the recurrence of secondary symptoms than any other mode of treatment whatever; and of all the kinds of mercurial fumigation, that by calomel is the safest and the most convenient, if not the most efficacious. The imbibition of the medicine through the skin prevents its injurious action upon internal parts; while the comparatively small quantity used, although quite sufficient to produce any amount of action that may be required, insures the patient against any sudden or violent effects.

In this mode of using mercury, the whole of the skin may act as an absorbing surface; and, when requisite, the effect may be still further increased by absorption from the mucous membrane of the nose, mouth, and bronchial tubes.

In secondary syphilitic disease, the surface of the body and the mucous membranes are peculiarly liable to be affected; and the process of fumigation has here this great advantage, that the remedy is applied directly to the diseased parts, and acts immediately upon them. When administered internally, it has, on the contrary, first to be absorbed into the blood, and carried the round of the circulation, perhaps more than once, before it comes into contact with the affected structures. Many old and intractable syphilitic ulcerations yield with surprising rapidity to local calomel fumigation; and there is no reason why the same principle should not be taken advantage of in treating the more general forms of the disease.

Calomel alone, without the vapour of water, may be used, especially where the local action of the medicine alone is required. But, from a series of comparative trials which were made in the early part of the year 1856, it became evident that, for the purposes of general fumigation, it was advisable that a small amount of the vapour of water should be present. In the process of sublimation some free hydrochloric acid is often given off, and the vapour of water so far dilutes this as to prevent its irritating the lungs.

The syphilitic poison, in a very great majority of cases, produces its principal effect upon the skin. Through this organ, nature attempts its elimination; and a free secretion from the skin assists the action which nature has already commenced.

It appears, from an extensive trial, that not only is the poison eliminated from the system more effectually where there is a free cutaneous action, but that under this condition the internal organs of the body are much less likely to be affected by the disease than under other circumstances. The calomel vapour-bath combines the various advantages now alluded to, and its great practical advantage is attributable : 1. To the small quantity of mercury which is required, when absorbed, in order to produce the requisite effect. 2. To the fact that the imbibition of the medicine through the skin leaves the digestive organs unirritated and the digestion unimpaired. 3. To the circumstance that there is something in the free secretion from the skin, which the combination of steam and calomel produces, that moderates and controls the mercurial action, and at the same time determines the secondary syphilitic actions to the surface of the body rather than to internal organs.

The action of the calomel bath should generally be continued until all syphilitic symptoms have disappeared, and for a week or two afterwards.

Local calomel fumigation. — Whilst the use of calomel fumigation over the whole body and with a view of producing a constitutional effect is so beneficial, its local employment is not less advantageous. Scarcely any case of syphilitic disease of external parts occurs which cannot be benefited in a marked degree by it. And whatever objections there are to its becoming of extensive application, they do not arise from any want of success in the treatment, but from a difficulty in obtaining proper apparatus.

Different kinds of apparatus have been used for local fumigation. The calomel-fumigating lamp previously described answers the purpose extremely well. The vapour of calomel, being of very light specific gravity, ascends, and any part placed over it becomes coated with a very fine layer of calomel. This forms an excellent dressing for intractable ulcers, whether of a primary or secondary nature. Tubes of various shapes have also been employed so as to direct the vapour of the calomel to particular parts. Thus, a long tube has been adapted to the calomel-lamp with a mouth-piece, for the purpose of inhalation in affections of the throat. A roll of paper has been often used with the same object. But it is evident that, as the calomel mixes with the air, the simple act of respiration does all that is required ; and as far as the throat is concerned, any tube is much more likely to detain the calomel than to direct its course. It is often, however, convenient to direct the vapour of calomel to parts which cannot well be brought over an ordinary lamp, and then an additional apparatus is necessary.

A reference has already been made to the inhalation of the mercurial vapour for the purpose of accelerating its constitutional effect, but in all cases of secondary sore throat, particularly those in which iodide of potassium fails to effect a cure, the inhalation by its local influence is exceedingly beneficial. The inhalation may be effected in the manner already described, or if for other reasons it is unnecessary or inconvenient to use the general bath, an apparatus similar to a steam inhaler, but provided with a lamp and basin for the calomel and water, may be employed. Such inhalation should not be continued for any length of time unless a constitutional result be desired. Four grains of calomel once or twice a day will generally be found sufficient.

In cases of primary sores on the penis, an apparatus provided with a tube capable of containing the whole organ is convenient. The use of the instrument may in these instances be continued sometimes for twenty minutes or more, and may be repeated daily or even more frequently till the sore is healed or at least furnishes a healthy secretion.

In cases of suppurating bubo another form of apparatus must be employed. The instrument must be furnished with a tube expanded into a funnel-shaped termination, and when in use a piece of macintosh should be wrapped round the instrument enclosing a space large enough to contain the whole of the diseased surfaces. The macintosh, by its flexibility and facility for adaptation to irregular surfaces, effectually retains the vapour in contact with the skin as long as may be necessary.

In some instances it is desirable to use local calomel fumigation to the arms and legs, and as the extremities are more easily isolated from the rest of the body, a simple modification of an arm or hip bath is alone sufficient.

CHAPTER XIII.

SYPHILISATION.

PROFESSOR BOECK recognised, as he believed, the general law that a seed repeatedly sown on the same ground would in time cease to fructify. Reasoning from analogy he conceived that the venereal poison, when repeatedly inoculated upon the same person, would in time so exhaust the susceptibility of the patient to the action of the poison, that no further manifestations of its existence would be produced. This repeated inoculation has been extensively tried both as a means of preventing and as a remedy for the disease.

Syphilisation, as it was called, was at first performed with the secretion from the local suppurating sore, on account of the facility with which that could be inoculated, and the difficulty which was experienced in inoculating the secretion of sores affected by the specific adhesive inflammation.

Danielssen used syphilisation as a means of treatment in lepers not affected with syphilis; and the experience thus obtained is conclusive, on the one hand, that no absorption of the virus took place in his cases; and, on the other hand, that the secretion used was not derived from a real syphilitic source. He gives the history of six cases, and, with reference to them, says:—

‘It appears from the above details, that neither one chancre, nor two, nor three, nor six, nor thirty-six, nor one hundred and thirty-six, have in the preceding cases induced secondary syphilis, and that, therefore, the direct operation of the inoculations has been exclusively limited to the spot where the chancres showed themselves. If such be the case, we are justified in assuming that no greater number of chancres will produce a different result. And this is confirmed by our experience; for, with one exception, to which we shall subsequently allude, not one of those individuals, previously free from all syphilitic taint, whom I have syphilised, have been affected by secondary syphilis; nor have they shown any signs of the existence of the venereal diathesis in their systems. Nor in those already affected with syphilis have I observed under syphilisation the slightest evidence of their having imbibed the poison afresh. So far from seeing in syphilisation a new physiological fact, as Boeck denominates it, I have, on the contrary, found it confirm a long-established axiom, viz. that the simple soft chancre does not affect the system, and consequently does not produce constitutional syphilis. Among the many thousand artificial chancres that I have seen, I have not observed one (with a single exception) which was not of this character, both in my own practice and in that of my colleagues, and as inoculated on every part of the body. Even on the face, the soft chancre followed inoculation, contrary to Ricord’s experience, who had always observed the indurated chancre there.

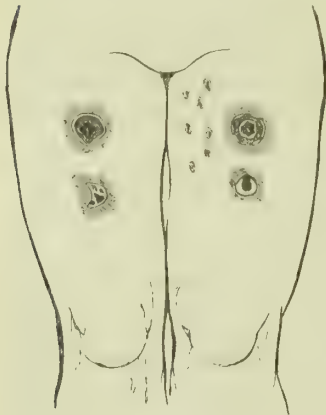
‘The exceptional case referred to in the above remarks is highly important, since it strongly confirms the position here assumed. Syphilisation had been performed upon a leper with the virus of the soft chancre to the extent of nearly four hundred inoculations, when the secretion of an indurated chancre was accidentally inoculated. The inoculated point healed, but *a month afterwards an indurated sore appeared, followed by unmistakable signs of secondary syphilis*, showing that the previous inoculations with the chancroidal virus, which had been strictly local in their action, had afforded no protection whatever against true syphilis.’

The mode of inoculating, with any degree of certainty, the secretion of an indurated sore upon the patient himself, or upon another syphilitic patient, was, I

believe, first pointed out by myself in an article in the 'British and Foreign Quarterly Review' for April 1859.

'Having observed,' I there stated, 'that the secretion from an indurated sore was inoculable under certain states of irritation, blisters were applied to some of these indurated sores, and subsequently they were dressed with the *unguentum sabinae*. By these means I obtained a free secretion of pus, and it was found that the secretion, before incapable of producing any effect upon the patients themselves, could now be inoculated. The results of these inoculations have been different from those which follow ordinary inoculations from suppurating sores.' In some cases I obtained an abortive form of adhesive inflammation in which there was no well-defined outline, and which did not suppurate or ulcerate. In other cases, after a certain amount of adhesive inflammation had taken place, suppuration and ulceration occurred; but unless there was some amount of phagedænic action produced, no loss of substance followed. The suppuration and ulceration were confined to the newly formed matter, and did not invade the natural structures. When syphilitic inoculation is performed with an irritating secretion on a patient, the subject of syphilitic fever, in whom an eruption in the natural order of things is due, the inoculation produces at once an

FIG. 83.—Results of Inoculations of the Vaginal Secretion of a Syphilitic Woman, showing increase of substance on each inoculated point.



action which depends in a great degree upon the condition of the patient at the time; and the inoculation so produced partakes also of the character of the affection from which the inoculated matter is derived. It is not the suppurating sore with loss of substance, previously described, which is the result, but it often more resembles a blind boil with increase of substance. It has not the defined characters of the primary sore on the one hand, nor of true primary syphilis inoculation on the other. The induration, instead of terminating abruptly, gradually diffuses itself into the surrounding parts. It is less distinctly marked than in the primary sore, and its tendency is to run much more rapidly into suppuration and elevation. The accompanying woodcut represents some inoculations made from the mucous secretions of a syphilitic patient upon another patient also syphilitic. There was not the slightest appearance of any syphilitic disease in the mucous membrane of the vagina from which the secretion

was taken, and the greatest care was exercised by Mr. Gascoyen and myself in performing the experiments. The inoculation showed a decided increase of substance, and resembled boils passing into a state of suppuration. The drawing illustrates two points—(1) The characters of the inoculations which may be produced by the inoculation of syphilitic matter on a syphilitic subject; and (2) the inoculability of the secretions of a syphilitic subject, taken from a part where there is no apparent syphilitic disease.

In the local venereal sore, on the other hand, there is always some loss of substance. Early suppuration and ulceration are among its characteristics, and it frequently leaves a permanent depression on the skin.

I do not mean to say that in true primary syphilitic sore pus is not formed, but it is so, if at all, after a long interval and in small quantity. If a vaccine vesicle be allowed to run its course after the scab is formed, some suppuration will take place, but one of its essential characteristics is, that in early stages it does not suppurate. Real primary syphilitic inoculation may therefore, as I believe, be distinguished in its origin from the local venereal sore, and both may be distinguished from the combined action of an irritating syphilitic inoculation upon a syphilitic patient; and this distinction must be borne in mind in considering how far one attack of venereal disease may prevent another. Now, physiologically, it is conceivable that a community might all be inoculated in their infancy with true syphilis; and in such a community we

might have every reason to believe that if syphilis subsequently appeared among them, it would be in a very mild and modified form. If the extinction of syphilis were the only question, the inoculation of children might be reasonably entertained. The disease in them is comparatively so mild, and so easily cured, that an individual might, as far as physical suffering is concerned, be a gainer by being inoculated in infancy. This is, in fact, the principle upon which inoculation with the small-pox poison was formerly practised.

Now, as neither the local suppurating sore nor the irritating secretions from syphilitic patients produce any constitutional syphilitic effects upon a patient's system, nothing of a strictly curative kind can be expected from the repeated inoculation from either of these sources: a period may, indeed, come when, after long-continued irritation, the skin is comparatively unsusceptible of any fresh action, and consequently less liable to become the seat of any fresh syphilitic manifestations.

Like most other diseases, syphilis has in time a natural tendency to wear itself out, and a continued action upon the skin may accelerate the natural termination of the disease; but, with regard to so called syphilisation, as a means either of prevention or of cure, it is doubtful whether most patients would not prefer the disease to the remedy.

HENRY LEE.

GONORRHOEA.

OF the diseases of the generative organs which, for the most part, take their origin from impure sexual intercourse, pathology and clinical observation have alike established the existence of three groups, separate and distinct from one another.

1. Gonorrhœa—an inflammation of the mucous membrane of some part of the generative organs, producing muco-purulent discharges. In the male this is sometimes attended with an inflammation of the testicle, and occasionally followed by symptoms referable to the joints and eye.

2. The soft, suppurating, contagious ulcer of the genitals, which differs from the next in the most important characteristic, viz. that it is localised in its sphere of morbid influence, and does not induce general or constitutional infection.

3. That disease which, commencing as a localised affection of some kind, generates those other and more general morbid symptoms denominated constitutional syphilis.

These all agree in the respect that they are contagious; and, however much opinions may differ as to the first, the two last have for their cause a specific virus.

The most frequent disease arising from sexual intercourse is, without doubt, gonorrhœa. This name, although somewhat incongruous—for the prominent symptom of the disease is not a flow of semen, as the derivation of the term indicates, but a muco-purulent or purulent secretion and discharge from the diseased surface—has been so long in use that its abolition would be attended with difficulty.

By some writers the affection is termed 'blennorrhagia.' By the vulgar it is termed the 'clap' in England and 'chaudepisse' in France.

There is every reason for believing that this disease has been known from very remote times. The sanitary measures inculcated by the Hebrew lawgiver in the 15th chapter of Leviticus have, in all probability, reference to this disease. It appears likewise to have prevailed among the Greek and Romans.

Very shortly after the irruption of syphilis into Europe, towards the close of the fifteenth century, a belief in the unity of species and cause of all the contagious diseases of the genitals became widely prevalent. Observers, perceiving that these diseases commonly originated from one source—sexual intercourse—referred them all to one and the same cause, embracing them alike in the common term of 'venereal.' The confusion and perplexity thus introduced continued to our own day. To the genius and sagacity of Ricord it is undoubtedly due that these almost insuperable difficulties to the right appreciation and study of these diseases have been removed.

Gonorrhœa is an affection of a totally different character to the primary syphilitic ulcer—whether we have regard to its history, pathology, symptoms, terminations and consequences, or its treatment.

Acknowledging all this, as is generally done in these days, there remain a number of well-observed facts which would seem, nevertheless, to militate against it. The writer alludes to those cases in which symptoms of secondary syphilis follow discharges from the urethra, apparently identical with those produced by gonorrhœal inflammation. The explanation usually given is, that when urethral discharges have preceded a syphilitic infection, such discharge has been symptomatic of a chancre within the urethra—chancre larvé of Ricord. In support of this theory it is alleged—1st, that intra-urethral chancres have been demonstrated in some such cases, and hence probably existed in the remainder; 2ndly, that the inoculation of urethral discharge

has been followed occasionally by the same phenomena as succeed the inoculation of the secretion from a chancre; 3rdly, that acquired constitutional syphilis, whenever its course has been observed, has invariably been preceded by some primary lesion of the nature of chancre, and hence that it is in the highest degree probable that the same process may occur within the urethra, where it is concealed from our sight, as happens in other parts patent to our observation. It is important to remember that those who deem the foregoing theory unsatisfactory, when applied to *all* cases in which constitutional symptoms have succeeded urethral discharge clinically identical with gonorrhœa, do not at all deny the existence of urethral chancre. They contend that all that can be said in these exceptional cases amounts to this—that the existence of chancre has been presumed but not demonstrated; and that from time to time cases of secondary syphilis follow discharges from the urethra, in which it has been quite impossible to distinguish the urethral disease from gonorrhœa, and wherein all the evidence at command was strongly against the existence of a chancre concealed within the urethra. Many deny altogether the existence of a chancre deeply seated in the urethra. Vidal, for example, does not admit such, beyond the navicular fossa. The transmission of a virus to a distant part of a canal like the urethra is confessedly difficult of explanation, and it has not been demonstrated to the satisfaction of many pathologists that the two morbid specimens of deep-seated ulceration of the urethra, upon which M. Ricord relied to establish his theory of the chancre larvé, were in reality chancres at all.

The importance of the subject renders it essential that we should endeavour to obtain clear views upon it.

From the time of Swediaur to the present day there has been a well-grounded belief in the existence of a syphilitic blennorrhagia. Hunter, who believed in the identity of gonorrhœa and syphilis, cites the results of his inoculation of pus from a gonorrhœa, which inoculation produced sores having all the characters of chancre, and were followed by symptoms of general infection. The case is related on p. 343.

This fact can neither be mistaken nor ignored. The explanation is well worthy of careful consideration. Two views may be assumed, either of which will yield a probable explanation: first, that the urethral pus was obtained from a concealed syphilitic sore (chancre larvé), alone and unmixed, or mingled with the products of a co-existing gonorrhœa. The second view rests upon the belief that not only the fluid products of secondary lesions, but that the blood and fluid excretions from a person constitutionally syphilitic, may produce that disease in a sound person by inoculation.¹

It ought not to be forgotten also that the mucous membranes are the frequent seats of the earliest constitutional manifestations, and that a muco-purulent discharge from the urethral membrane is an occasional symptom of secondary syphilitic infection.²

Hunter conceived that the pus from a chancre or blennorrhagia applied to a secreting surface (mucous membrane) would invariably produce gonorrhœa; but when inoculated on a non-secreting one, such as the skin, it would equally always develop a chancre.

It is true that this pathology cannot hold its place in the presence of later observations and experience; but there are not wanting a few, though extremely rare, facts corroborative of the truth of Hunter's view of a 'physiological absorption'—*i.e.* the absorption of virus into the blood, without any lesion of the surface to which it is applied.

The *bubon d'emblée* is an example of this. When we speak of primary infecting

¹ See the writer's work on *Practical Pathology*, vol. ii. 1870; also Viennois, in *Archives gén. de Méd.* June 1860.

² Rollet seems to have arrived at the conclusion that, although the blood of syphilised persons is inoculable, pus derived from them is not. He says that, if pus be taken from the urethra of a syphilitic person suffering from gonorrhœa, but whose genital organs are free from syphilitic eruption, and if this pus be inserted in the mucous membrane of another, free from any syphilitic taint, an ordinary gonorrhœa only succeeds. If blood, however, be taken and mixed with the pus, then both gonorrhœa and syphilis may follow. *Vide* Basereau, *Affections syphilitiques de la Peau*, p. 355.

sores, we must remember that these do not all alike possess the same objective signs. A primary syphilitic lesion may possess scarcely any induration, and the same may be said of its ulceration or erosion, the amount of which may be barely appreciable. We are ignorant how far the physiological properties of the deeper tissues of the urethra may affect the development in them of specific disease, because of our inability to watch the morbid processes in these parts.

A purulent fluid from the female organs of generation is commonly the cause of gonorrhœa in men. Now if such a fluid be obtained from a woman constitutionally syphilitic—and uterine discharges are very frequently indeed present in such women—there is no reason against its being the vehicle of a syphilitic virus.

Discharges from the urethra and mucous passages of the generative organs may arise from the application of various purulent and irritating secretions to the mucous membrane, or be symptomatic of some constitutional or other disease.

The causes of blennorrhagia will fall under one or other of the following heads:—

1. The application of a gonorrhœal discharge to a part of the sexual organs—direct contagion.

2. Certain irritating substances applied to the mucous membranes—*e.g.* menstrual fluid, leucorrhœal discharges, and other irritants, rather interesting to the pathologist than of any practical value to the surgeon, such as the injection of a solution of ammonia, as in the experiment of Swediaur upon himself.

3. Urethral discharge may arise from constitutional and other causes, irrespective of any contagious influence; as in gouty or rheumatic subjects, and after the use of certain drugs.

Complaints closely resembling gonorrhœa sometimes appear in persons the subjects of stricture or irritable urethra, after sexual intercourse, a debauch, or other excitement.

Occasionally, though very rarely indeed, venereal excitement alone may induce a blennorrhagia of the urethra.

As most people are aware, gonorrhœa is very frequently the result of direct contagion, from intercourse with a person similarly affected. It is needless, therefore, to enlarge upon this; but it is of the utmost importance, in a medico-legal sense, to remember that the symptoms of gonorrhœa may be produced by various agents other than the application of gonorrhœal pus.

It is absolutely certain that gonorrhœa in the male may proceed from intercourse with a woman in whom no morbid changes in the genital organs can be detected upon minute examination even with the speculum. Ricord's remarks upon this subject deserve attention. He says:—

‘If we investigate with the greatest care the exciting causes of gonorrhœa—and I am now speaking of characteristic cases of the disease—we cannot help admitting that a gonorrhœal virus is absent in the majority of cases. Nothing is more common than to find women who have occasioned gonorrhœa unsurpassed in intensity and persistency, and attended by the most serious complications, and who are yet only affected with uterine catarrh, which is sometimes hardly purulent. In many cases intercourse during the menstrual period appears to be the only cause of the disease; while, in a large number, we can discover nothing, unless, perhaps, errors in diet, fatigue, excessive sexual intercourse, the use of certain drinks, as beer, or of certain articles of food, as asparagus. Hence the frequent belief of patients, which is very often correct, that they have contracted their gonorrhœa from a perfectly sound woman.

‘I am most assuredly familiar with all the sources of error in such investigations, and I will presume to say that no one is more guarded than I am against the various forms of deceit which are strewn in the path of the observer; yet I confidently maintain the following proposition: *Gonorrhœa often arises from intercourse with women who themselves have not the disease.* Anyone who studies gonorrhœa without preconceived notions, is forced to admit that it often originates from the same causes that give rise to inflammation of other mucous membranes.’¹

¹ *Lettres sur la Syphilis*, 2nd edit. p. 29.

Diday says emphatically, '*that from the very fact of a woman having a discharge, no matter what its origin, she is liable to give a discharge to a man.*'

Fournier, as the result of his investigations relative to the classes of women from whom gonorrhœa is derived, conceives that gonorrhœa is much less frequently contracted from contagion than from excessive coitus, or peculiar excitement during the act.

The opinions of many English surgeons, particularly those of Mr. Skey and Sir Henry Thompson, are to a similar effect, that a gonorrhœa may be produced by causes other than a specific poison. Those who oppose this view seem to do so upon the grounds that a gonorrhœa is confessedly a highly contagious disease, and that cases of gonorrhœa so caused differ, in the degree and intensity of the symptoms, from a urethritis excited by other causes.

The truth of the latter statement is somewhat questionable; but, however this may be, it will not affect the question.

The fact of the disease being so commonly caused by impure sexual intercourse is proof of the presence and action of a poison, but only of such a one as is capable of being produced by simple inflammation. A little consideration will serve to remove the obscurity about this subject.

Opinions have been much modified of late concerning the 'specificity' of inflammations. Van Roosbrück's experiments go to prove that an ophthalmia may result from the inoculation of any pus, and that the true morbid property of that fluid depends upon the cells; for when it has been deprived of such by filtration, the remaining liquor appeared innocuous. Mr. Simon, in his essay upon 'Inflammation' (vol. i. p. 26), remarks: 'There is ample room to question the popular impression that only specific inflammations are communicable; much reason for suspecting it, on the contrary, to be a generic and essential property of inflammation, that its actions (or some of them) are always in their kind, to some extent, contagious.' Simon quotes from Dr. Guilié's and Sir Patrick M'Gregor's experience upon the occasional contagious properties of infantile and common catarrhal ophthalmia, and cites Dr. Piringer's experiments to the effect that he had succeeded eighty-seven times in exciting conjunctival inflammation by the contact of an inflammatory product (pus), taken from sources the most various.

The experience obtained at some of the London Ophthalmic Institutions is corroborative of the truth of the statement, first made by Van Roosbrück, that as the inflammation, which has produced the pus used for inoculation, has been active and acute, so will the artificial inflammation excited by it be severe in its character.

In this way gonorrhœal pus, applied to the conjunctiva, exhibits far more active properties than pus from most other sources.

It follows from this that the observations of practical surgeons are borne out by modern pathology, and that a gonorrhœal discharge may be the result of other than specific pus.

There is yet another mode of explaining some of those cases in which an individual has contracted a venereal affection from one in whom no disease can be discovered. The doctrine of 'mediate contagion,' as it is called, so long regarded as highly probable, has recently received experimental proof at the hands of M. Cullerier. Although the experiments were made with the secretion of a chancre, their bearing upon the subject of gonorrhœa is evident.

Louise Vaudet, aged 16, entered the Hospital of Lourcine, ward of St. Mary, No. 9, upon October 10, 1848. She bore on each thigh an ulceration with a grey floor and abrupt edges. The disease dated a month. On November 25, after having ascertained beyond a doubt that the mucous membrane of the vulva and vagina was not ulcerated in any part, and that the discharge from these parts was not inoculable, I collected upon a spatula the pus produced by one of the inguinal chancres, and laid it in sufficiently large quantities in the vagina. I made the patient walk up and down during thirty-five minutes, taking care to watch her, so that she might not place her hand on the vulva. After this lapse of time, I placed upon a lancet a certain quantity of the vaginal secretion, and I inoculated with it one of the patient's thighs. I then washed with water the vagina and vulva; I carefully wiped the parts, and then washed them again with a strong solution of alum. Forty-eight

hours after, the puncture of inoculation had produced a characteristic pustule. I left it till next day, so that the experiment might be more certain, and then destroyed it with Vienna caustic. Nothing whatsoever appeared in the vagina; the inflammation was not increased, and after two months the patient quitted the hospital perfectly cured of the vaginitis, as well as of the inguinal ulcerations.

The second experiment was made upon Celestine X—, aged 24, who entered Lourcine, ward of St. Louis, No. 7, on November 28, 1848. She bore on the left thigh an ulcerated bubo of two months' date, and which, according to her, had succeeded a pimple, seated on the internal surface of one of the labia majora, which had only lasted for a few days. At the time of her admission into the hospital no trace could be discovered of this pimple. The vulva, the vagina, the neck of the uterus, and the anus were all in a perfectly normal state. The aspect of the ulceration on the thighs made me suppose that it was specific. On the day following, the 29th, the pus proceeding from the bubo was placed upon a spatula and laid in the vagina, care being taken to carry it as high as possible. The patient was then made to walk about for an hour, without knowing that she was the object of an experiment. She was taken back to bed; and I then collected as much as I could of the vaginal mucus, remarking to some pupils and young colleagues who surrounded me that none of the pus introduced into the vagina could be seen, and that what I had on my lancet was entirely similar to the normal mucus. I inoculated one of the thighs, using the same precautions in washing as I did in the former case. After two days, the characteristic pustule rose, and I only destroyed it after forty-eight hours. The vulva, vagina, and the neck of the uterus were carefully observed during several days, but nothing appeared; the disease restricted itself to the thigh. I must not neglect to say, that although there was no sign of disease in the interior of the organs of generation, yet I made on the same day an inoculation with the mucus with which they were covered, and obtained a negative result.¹

From these observations it results that the female may be the vehicle of disease without being herself affected; and that a virulent pus may be retained in contact with the vaginal tissues for a certain time without producing that diseased action which it is capable of inducing elsewhere.

Seat and progress of the disease.—Gonorrhœa or blennorrhagia is an inflammation, ordinarily acute, of the mucous membrane of the urethra or some other parts of the genito-urinary tract, and accompanied by a muco-purulent or purulent discharge. In the male it comprehends varieties according as it is located in the urethra, upon the prepuce, or glans penis. It may be confined to one of these parts only, or occupy more than one, or all, at the same time.

Gonorrhœa of the nose, mouth, anus, &c., have been described; but the existence of these is open to question, and they are relatively of such rare occurrence that we may practically discard them.

Differences of opinion are entertained as to the exact seat and extent of the disease in the male urethra; some conceiving that it commences exclusively at the fossa navicularis, others at a part further back; while Astruc thought that it had its special seat in the various glands and the reservoirs. No doubt some differences will be found to exist in different cases, alike as to the extent of the membrane involved and the acuteness of the inflammatory process.

The ordinary seat, however, of the disease is in the more superficial layers of the mucous membrane, and the inflammation affects the orifices of the follicles and lacunæ in the urethra. It commences, for the most part, at the fossa navicularis and the neighbouring mucous membrane, and, as it advances, spreads backwards, by contiguity and continuity of tissue, to the posterior parts.

The points at which the inflammation remains most commonly fixed, and in which it is manifested with the greatest intensity, are the fossa navicularis and the vicinity of the bulb. The appearances noticed by Hunter, Sir Astley Cooper, and Ricord in their dissections were, inflammation of the urethra, without breach of surface; and these appearances were most marked within two inches of the meatus and at the bulb. Although this is an adequate expression of the seat and extent of the inflammation in most cases, in some it is far otherwise.

Gonorrhœal inflammation does not ordinarily affect the whole of the urethral mucous surface, but in some cases, as Wallace remarks, it may be diffused over a wide surface, and 'may involve at the same time the whole of the urethra, the bladder, the testicles, the glans, the prepuce, in the male; and in the female, the nymphæ,

¹ Condensed from Dr. Cullerier's work, *Des Affections blennorrhagiques*, 1861.

clitoris, labia, vagina, &c. and thus commencing at the preputial end of the penis, in the fossa navicularis, it not unfrequently creeps slowly on to the posterior parts of the urethra, to the bladder, or to the testicles, while it decreases or ceases entirely in the parts first affected.'¹ It may be confined to the mucous membrane only, or extend to the tissues beneath. Sometimes it would appear that the inflammation is localised to some part of the canal, inducing thickening and effusion into the sub-mucous tissues, and maintaining for a long period a scanty purulent or gleet discharge.

In the chronic stages, the mucous membrane may become granulated like the palpebral portion of the conjunctiva in chronic ophthalmia.

GONORRHOEA IN THE MALE.

Men are much more liable to contract this disease than women.

The first attack is generally the most severe, and a kind of tolerance of the disease is commonly found to follow repeated attacks. The symptoms usually appear from the second to the fifth day after exposure; sometimes, though rarely, at later dates.

The progress of the disease may be conveniently divided into four stages.

I. The symptoms are at first very slight, consisting of an itching or tickling sensation of the meatus; this is found rather more florid than normal, and the lips of the canal are glued together by a small quantity of viscid colourless secretion. This moisture augments in amount, but continues scanty, and passes from the clear watery appearance to one of opalinity. Slight puffiness of the lips of the meatus appears at this time. There is no ardor urinæ at this stage, but only such modifications of sensation as amount to a trifling smarting.

This stage may last from a few hours to two or three days.

The inflammation, such as it is, is incipient in degree and limited to the neighbourhood of the meatus and fossa navicularis.

This is the premonitory stage.

II. The symptoms gradually increase in intensity until a highly inflammatory condition is reached. The mucous membrane of the glans is swollen and inflamed, and the entrance of the meatus appears also swollen and florid. Sometimes there is œdema of the prepuce, slight in degree, or sufficient to cause phimosis. The discharge augments rapidly in amount, loses its opaline character of muco-pus, and becomes a thick creamy pus with a tinge of green. The penis and course of the urethra feel tender and swollen to the touch. The slight smarting increases to a severe degree of scalding in passing the urine. The patient voids it with difficulty in a smaller or forked stream; oftentimes it makes its exit in jerks, alternating with the spasms of the muscles lining the urethra. When the mucous membrane about the bulb is affected, the patient suffers from pain and weight in the perinæum, which are augmented in voiding the urine.

At night, when the sufferer becomes warm in bed, he is liable to attacks of involuntary erection and chordee. This latter term is applied to that arched or bent position which the penis assumes in erection. The explanation generally given of this phenomenon is this: the urethra, the chief seat of the inflammation, runs along the under surface of the penis. The lymph, which is apt to be effused around this canal, renders it less extensible than that portion of the organ composed of the corpora cavernosa. Hence, in a state of erection, the corpus spongiosum surrounding the urethra, not yielding to the distension, acts like the string of a bow, and chordee is produced. Mr. Milton conceives the mechanism of chordee to be due to spasm of the muscular fibres, described by Mr. Hancock and Professor Kölliker as surrounding the whole course of the urethra.

Abscesses occasionally form in the areolar tissue surrounding the urethra, either anteriorly to the scrotum or in the perinæum. It is not uncommon, also, for one of

¹ Wallace, *Treatise on the Venereal Disease*, pp. 237, 238.

the lacunæ of the urethra to inflame, suppurate, and form a small abscess (lacunar abscess).

This stage lasts from one to three weeks ; the continuance or not of inflammatory phenomena depending very much upon the constitution of the individual, his mode of life, and the number of previous attacks.

The disease, having ascended by a rapid course to a period of maximum severity, gradually subsides and loses its more acute symptoms.

III. This is the stage of decline ; the symptoms and discharge having run through the same phases, in an inverse order to that which they took at the outset of the attack. There is a marked diminution or entire cessation of scalding in passing water ; the penis is no longer hot, painful, or tender ; the involuntary erections and chordee being absent altogether, or, more commonly, of less frequent occurrence. The discharge slowly diminishes in amount, partaking less and less of the characters of pure pus, and, before disappearing, consisting almost entirely of mucus.

This stage is both longer and more uncertain than the preceding ones.

IV. The last stage does not occur in all cases. It is known by the name of blennorrhœa or gleet, and comprehends a slight but chronic discharge from the urethra, unattended by symptoms of inflammation.

It is impossible accurately to define a line of separation between this and the previous stage, which it generally follows without interval.

A very scanty discharge occurs every morning upon rising from bed, and the lips of the urethra appear gummed together. By pressure, perhaps a small amount of matter can be expelled. The characters of this discharge will vary according as it is the product of a chronic inflammation of some part of the mucous membrane alone, or mixed with the various glandular secretions. Sometimes it is a glairy mucus ; sometimes a concreted pus, or a prostatic secretion, or a combination of these. This state is liable to be increased, and attended with irritability of the urethra or bladder, under the aggravation of some such exciting causes as coitus, a debauch, &c.

There are no further symptoms ; but the disease is apt to prey upon the patient's mind, and so derange his health and assimilative powers. Haunted by his fears and morbid suggestions as to impotence, he may be deemed fortunate if he escapes the clutches of some advertising charlatan.

Gleet is often the result of an imperfectly cured gonorrhœa ; sometimes it is due to a localised chronic urethritis of the bulb, organic changes within the urethral canal, such as stricture, or mucous vegetations, or it is maintained as a consequence of one or more of the urethral glands having become involved in the blennorrhœal inflammation.

From whatever source it arises, it is liable to be kept up by certain bodily conditions, congenital or acquired, such as a general debility or delicacy of constitution ; a strumous, rheumatic, or gouty diathesis ; or a lymphatic temperament.

Hunter, in his work on the ' Venereal Disease,' speaks of gleet as perfectly innocent with respect to infection ; and adds that in the relapses, which so frequently occur, the virus, in his opinion, does not return. Nothing can be more dangerous than the practice which would follow from such a doctrine. Even if the purely gleet discharge were proved to be innocuous, we know that it is liable to a puriform change upon many and apparently slight exciting causes, and then it would, without doubt, be capable of inducing disease in another. So long as *any discharge exists*, sexual congress is unsafe.

Pathology.—While the gonorrhœal inflammation attacks very commonly the straight part of the urethra, and may indeed go no further, the gleet discharge is more frequently the product of changes going on at a deeper seat—the neighbourhood of the bulb.

Sir H. Thompson remarks : ' Observation demonstrates that the two spots which suffer most from gonorrhœal inflammation are the fossa navicularis and the bulb. I have had opportunities of observing this two or three times in the dead-house, on the bodies of patients who had been suffering from gonorrhœa shortly before death.

Unusual vascularity is found in the latter situation, particularly if the disease have been chronic, while the intermediate part appears comparatively very little affected. There is a preparation in the Museum of St. George's Hospital which exhibits the urethra of a patient who died while suffering from gonorrhœa, in which an ulcer exists (the only one to be seen) in the commencement of the membranous portion.¹

A well-marked attack of gonorrhœa in the male may be termed a severe local disease, and rarely terminates in less than three months if no treatment has been applied.

The reaction of the disease upon the system varies very much in different individuals, and in different attacks in the same person. In some cases, a well-marked pyrexial state attends the inflammatory stage of the complaint. Generally, however, there is a comparative if not entire absence of constitutional symptoms. In other cases there is certainly a marked tendency to depression of the general health; anæmia is induced, and the sufferer has a pallid and listless appearance of face. These effects will be more markedly evidenced in delicate subjects.

Varieties of the disease.—A variety of gonorrhœa has been described as a 'gonorrhœa sicca.' It must be very rare, and it has not fallen within the observation of the writer. The symptoms would be those of inflammation, such as heat, redness, and swelling of the parts, with scalding in voiding urine and painful erections, but without the discharge which forms so prominent a character of the ordinary form of gonorrhœa.

Gonorrhœa externa, or balanitis, is an inflammation of the surface of the glans and mucous lining of the prepuce, attended with profuse discharge. It may arise from the same causes as the urethral form, and is particularly apt to occur in persons possessing a long prepuce. A similarly diseased state may be induced by want of cleanliness; a retention and decomposition of the secretion from the preputial glands; and sometimes it occurs as an indication of disordered health.

In severe cases, the prepuce may rapidly inflame and swell, with great pain and febrile symptoms, phimosis being induced. In chronic balanitis with phimosis it is frequently found, upon exposure of the mucous lining of the prepuce, that it is rough, fleshy, and studded with granular prominences.

Excoriations and erosions of the glans and prepuce are frequently present, and it is of great importance to remember that a balanitis with such erosions may be the precursor of general syphilis.

Upon the glans penis an erosion or rawness is often only the commencement of a primary sore, and induration of the preputial tissues may appear subsequent to healing at the base of the excoriations, so that under such circumstances we must always give a very guarded diagnosis and prognosis.

The treatment of balanitis may be summed up at once. It consists of perfect cleanliness, with frequent applications of warm water or an astringent lotion. Lime-water is a good application when there is much inflammation. When there is much discharge without great inflammation, dusting the parts with a mixture of finely powdered calomel and calcined magnesia is a capital treatment. It can be applied at night, and removed by an astringent wash in the morning.

If the excoriations have not healed in a few days, a solution of nitrate of silver will generally be effectual. A saline aperient and rest are often indicated.

Before passing to the general question of the treatment of the disease several complications which occasionally occur may be briefly noticed.

1. There may be severe irritation or actual inflammation of the urinary organs, sometimes of the deeper portion of the urethra, producing great pain in the perinæum, with spasm of the external and internal layer of muscles during micturition. This may cause such pain and difficulty in voiding the urine as to occasionally produce complete retention. Sometimes the bladder is affected, causing a constant desire to make water, and pain in doing so, which lasts for some time afterwards, together with mucous deposits in the urine. Or there may be symptoms of renal irritation, marked by pain in the loins, pyrexia, vomiting, and bloody, albuminous, or purulent urine.

¹ *Stricture of the Urethra*, p. 84.

This state, with or without symptoms of vesical inflammation, is likely to be induced by strong or untimely injections, absence of rest, alcohol, and the use of large doses of copaiba.

2. Hæmorrhage from the urethra. This is likely to occur during chordee, or violent erections, from rupture of some of the distended vessels. It is rarely large in amount, and exercises a beneficial influence rather than otherwise. In passing, it may be remarked, that the green hue of the urethral discharge is probably due to altered hæmatine being mixed with the pus.

3. Inflammation, leading to suppuration of some of the mucous follicles of the urethra. Sometimes this is confined to one follicle; sometimes an abscess forms both in this and the neighbouring tissues subjacent to the mucous membrane. The swelling thus arising may greatly impede the flow of urine, until it bursts either into the urethra or externally.

4. Inflammation of the lymphatic glands—constituting some form of bubo. Buboës generally make their appearance during the second or inflammatory stage. They are of rare occurrence, except in persons of delicate constitution and lax habit, or when the patient has neglected to rest during the disease. One or more inguinal glands enlarge and become tender, causing uneasiness in the erect position. The areolar tissue and skin around such glands may become red and inflamed. If the patient maintains the recumbent posture, and counter-irritation—such as painting the part with a strong solution of iodine, or a blister—be applied, an abscess is generally avoided. In strumous, lymphatic, and debilitated subjects, an abscess will sometimes occur; or one of the glands will become much and chronically enlarged, the superimposed tissues may slowly inflame, and abscess with sinuses may follow.

The lymphatics along the dorsum of the penis sometimes are also affected. These vessels may be felt enlarged, but not indurated, as in cases of primary sores; the areolar tissue about them inflames, and the skin is generally congested and red; the pain and tenderness are plainly marked; and sometimes an abscess occurs at the root of the penis. When an involuntary erection occurs, these inflamed lymphatics may prevent the equable expansion of the organ, and give rise to a modified form of chordee.

5. Balanitis has been already alluded to.

6. Phimosis and paraphimosis may likewise occur.

The terms *phimosis* and *paraphimosis* are applied to two exactly opposite conditions of the penis. In the first it is difficult or impossible to retract the prepuce behind the glans penis so as to uncover it; while in the second the difficulty arises in returning the prepuce so as to cover that part of the organ.

Cases of phimosis are referable to three heads: 1st, congenital; 2nd, accidental, or acquired; 3rd, and not unfrequently, a combination of these two causes, as when some inflammatory disease has attacked the tissues of the prepuce or glans, and so either diminished the calibre of a naturally narrow orifice, or increased the dimensions of the contained part.

The congenital form is very common. In some cases there is not only a narrow orifice to the prepuce, but this is associated with adhesions between the opposed mucous surfaces of the glans and its covering. The majority of cases, however, are dependent upon the narrow orifice only, but there generally exists at the same time a redundancy of preputial tissue.

Although this congenital condition is compatible with perfect health, and may give rise to no obvious inconvenience, still it is a frequent source of irritation from a retention of the secretions, and must without doubt increase the liability to disease from sexual intercourse.¹

Most surgeons have witnessed cases in which, where this congenital formation has not been interfered with, it has given rise to some impediment to the discharge of urine; in a few rare cases this has been so great that the prepuce has become the receptacle of a certain amount of urine; when this condition becomes chronic, the

¹ See Mr. Hutchinson's interesting statistics upon syphilis as affecting the Jews, *Med. Times and Gaz.* December 1, 1855.

preputial tissues may be much hypertrophied and distended from the retention of urine and the irritation which it sets up. Various and manifold are the symptoms and diseases which have been referred to congenital phimosis. One of the most important of these is atrophy of the glans, its normal growth and development being impeded.

Among other evils to which an elongated or adherent prepuce may give rise, there ought to be mentioned vesical irritation, incontinence, or even retention of urine. In young children, prolapsus recti may further complicate the symptoms. The suspicion of calculus, of course, arises in such cases, which are not infrequent in the practice of large hospitals. The removal of the prepuce by circumcision, and the careful separation of the prepuce from the glans penis, will suffice to cure such cases.

Acquired phimosis depends upon some inflammatory or other disease of the prepuce or glans—particularly in those who naturally possess a long and narrow prepuce. Such an inflammation will give rise to swelling of the glans, or thickening or contraction of the prepuce. Among these accidental causes we have balanitis, secondary sores, vegetations, the widely-spread induration of a chancre, and the contraction arising from the cicatrisation of these, more especially when they have been seated upon the margins of the prepuce.

In relation to this subject may be noticed a localised hypertrophy of the preputial tissues as a sequence of chancre of those parts. This consists of an ill-defined, diffused thickening, with or without a small amount of œdema, and is essentially chronic.

The treatment will be operative or not, according to the cause and degree of the affection. If the glans can be uncovered, then the habit of doing this, with attention to cleanliness, will often be sufficient. In the congenital form, the operation of circumcision may be at once performed: Such is not the case, however, in the forms depending upon accidental causes. The surface of a wound is then apt to be inoculated with the fluid secretions from those temporary affections which have caused the phimosis. The same caution applies to the application of leeches to the inflamed prepuce. By rest, fomentations, a saline purge, and the repeated injection of tepid or cold astringent lotions, or the remedies necessary for the healing of any ulcer, the inflammatory swelling and, with it, the phimosis may disappear; if not, an operation may be necessary.

The operations for phimosis are of two kinds, according as we seek to reduce the length of the prepuce at the same time that we give it a free movement over the glans penis, or as we simply desire to effect the latter object.

Circumcision is the operation required in children, and it is best adapted for adults also when the skin is redundant and the margins of the preputial opening are thickened. Different plans of operating have been devised. One of the simplest and best is the following:—

The prepuce is to be seized with the fingers, or a pair of forceps, at its orifice, and drawn sufficiently forwards, when an assistant grasps and compresses it with a stout pair of forceps immediately in front of the glans. The skin being thus put upon the stretch, it is severed with one stroke of a bistoury immediately in front of the forceps. The mucous lining, which will be found to be still undivided and covering the glans penis, is then to be cut upwards from the orifice, by means of a pair of blunt-pointed scissors, or by a bistoury on a director, and the frænum is to be snipped through if necessary. Any small arteries are to be tied, and the mucous and tegumentary surfaces are to be connected with interrupted sutures, five or six of which will be necessary. If any adhesions exist between the mucous surfaces of the glans and prepuce, these are to be divided, or torn through by stripping the roll of membrane of the latter off the former. In adults circumcision is the best method of proceeding, as it leaves little or none of that disfiguration which is apt to follow the division of the prepuce simply.

When the prepuce is of natural length and appearance, except that the orifice is painfully tight, Sir W. Fergusson recommends that 'the point of a director should

be pushed in front, between the glans and prepuce, about half an inch up, and then a narrow sharp-pointed bistoury should be thrust from within outwards, by which means a wound half an inch in length will be made in the skin. The incision in the mucous membrane will then scarcely appear so long as that in the skin, and it should be lengthened with scissors, and then two, three, or four stitches should be introduced with a fine needle.' It is unnecessary, as well as a cause of deformity, to divide the parts as high as the corona, as some do. Instead of the above plan it has been recommended to make two, three, or four small cuts through the mucous membrane and prepuce at different parts of its edge. This is at least quite as painful, and certainly a less satisfactory method than that described. Sir B. Brodie was in the habit of recommending the division of the prepuce near the frænum; this operation he thought was attended with less subsequent deformity than any other.

It may be well to add a word or two in the way of caution about these simple operations. 1. Sutures ought always to be employed to bring the parts together, with the view of expediting the process of healing, and preventing the contraction which is apt to ensue when the wound is left to heal by granulation. 2. When circumcision has been performed, the small arteries—particularly any in the neighbourhood of the frænum—should be ligatured at the same time, because these are apt to bleed profusely afterwards, when the patient gets warm in bed, and so consequences very unpleasant to him and the surgeon may ensue. 3. In cases where the phimosis has resulted from disease, and where the prepuce is inflamed, œdematous, or where we have reason to suspect concealed chancres, it is well not to operate, because the wound will very likely be inoculated, and take on an unhealthy action. The phimosis in such cases is to be overcome by local or constitutional treatment. In some cases the division of the prepuce is essential not only for the discovery and treatment of the diseases which it conceals, but in order to prevent or limit a destruction which may be threatening from the pressure and constriction of the engorged prepuce and the retention of foul discharges beneath it.

The condition known as *paraphimosis* occurs thus: a narrowed and difficultly retracted prepuce, perhaps, is drawn beyond the prominent edge of the corona glandis; in a short time the circulation becomes so impeded by the pressure of the constricting preputial orifice, that tumefaction ensues, with the effusion of serum and lymph, to such an extent as to bury the seat of stricture in a deep furrow. The consequences will then depend upon the tightness of the stricture, its duration, and the amount of inflammatory swelling. Ulceration or extensive sloughing may ensue, by which the stricture is relieved at the expense of much loss of tissue and horrible pain.

If we look at the penis so affected, we notice that immediately behind the glans there is a prominent roll or collar of mucous membrane, with another, though less prominent, swelling of the integument beyond this, separated from each other by a narrow line or furrow. It is at the bottom of this furrow that the constricting cause is seated.

This affection is not uncommon in boys.

The treatment will consist in reducing the parts to their normal position without delay. We may apply ice, or direct a stream of cold water upon these so as to constrict them as much as possible.

As the proceeding for reduction is, in most cases, extremely painful, chloroform may be used. The patient is to be placed upon his back: the glans penis is to be well oiled, and covered with a piece of thin rag. With the fingers of the right hand the glans is to be gradually, but firmly, compressed so as to diminish its size: at the same time, with the left hand encircling the body of the penis, the integument is stretched and drawn forwards, while the compressed glans is pushed backwards through the narrow ring.

Should this not succeed—which it generally will—the seat of stricture can be divided by directing a narrow bistoury flatwise beneath it, and then turning the edge upwards; or by cutting through the stricture upon the dorsum of the penis at

the bottom of the furrow. It may be necessary to do this in more than one place, and at the same time to evacuate effused fluids by scarifications and punctures.

7. *Chronic inflammation of the prostate* is an occasional result of gonorrhœal or gleet inflammation.

To Mr. Adams's work¹ the reader is referred for a very full and admirable description of it, as well as to an excellent article by Mr. Ledwich.² See also DISEASES OF THE URINARY ORGANS, p. 196; and 'Lectures on Syphilis,' by the author.

The inflammation is blennorrhœal in type, leading to the discharge of a clear, transparent, or slightly turbid viscid mucus.

This discharge may be sufficient to stain the linen, and is very apt to escape during the act of defæcation. It is *not* semen, as it contains no spermatozoa. The disease gives rise to a sense of weight in the perinæum, symptoms of irritability about the neck of the bladder, a peculiarly exalted sensibility of the prostatic portion of the urethra on passing instruments, and is almost invariably accompanied by physical and mental languor and depression of spirits, sometimes amounting to hypochondriasis.

The treatment will consist mainly in obtaining the patient's confidence, and disabusing his mind of morbid fears as to impotence. Attention to hygiene is important; sea-air and bathing, exercise, the regulation of the bowels by cold-water enemata or an occasional dose of sulphate of magnesia, the use of a full-sized bougie or sound, and the administration of the remedies indicated for gleet—particularly turpentine, the muriated tincture of iron, strychnia, and *tinctura lyttæ*. If these fail, Lallemand's porte-caustique may be used. The author has found considerable benefit in these cases from touching the prostatic portion of the urethra with dilute solution of the perchloride of iron. This does not give the pain, and is free from some of the other inconveniences attending the use of caustic.

Gonorrhœa is not, ordinarily, attended or followed by any cutaneous diseases. The writer has, however, noticed the appearance of a papular erythema in many cases—not depending upon the administration of balsam of copaiba. The subjects of it were suffering from those dyspeptic symptoms so very commonly present in diseases of the genito-urinary organs, and, in the writer's opinion, the eruption was symptomatic of the gastric disease. It is characterised by dull red or pinkish-yellow spots, of various but medium size, and sensibly elevated above the surface. The colour disappears under pressure of the finger, and slowly reappears upon its removal. Sometimes these spots are mingled with the larger wheals of urticaria. The eruption is rather sudden in its appearance; ordinarily does not last more than a few days, and leaves no copper-staining.

8. *Herpes preputialis* is not an uncommon affection, and requires a few words of comment here, on account of the similarity of its appearance to the incipient forms of primary chancre.

It is known by the appearance of small vesicles upon the internal or external surface of the prepuce.

The disease commences in the form of several red inflamed spots, upon which minute globose vesicles appear. These vesicles are generally arranged in groups of two, three, or four.

The affection runs the ordinary course of herpes, but the serous fluid, instead of being absorbed, becomes sero-purulent, and (after rupture of the vesicle) desiccates into a thin scaly incrustation, or leaves an extremely superficial erosion. A circle of vesicles sometimes surrounds the orifice of the prepuce, which is then apt to become fissured and abraded. This affection is accompanied by more inflammation when seated upon the mucous membrane than upon the external skin, but rarely lasts longer than four or six days.

According to Dr. Burgess a similar herpetic affection attacks females about the

¹ *Anatomy and Diseases of the Prostate Gland*, 1853.

² *Dublin Quarterly Medical Journal* for August 1857.

puddendum, appearing upon the external aspect of the vulva or on the mucous membrane internally. This may be mistaken for prurigo.

The diagnosis from incipient chancre—not by any means always easy when the period of observation is very limited—will be determined by the number and appearance of the vesicles, their arrangement in groups, the non-inoculability of their fluids, and their speedy cure by simple remedies, such as sulphate-of-zinc lotion (gr. iij.-iv. to the ounce), with a little lint for protection against friction.

9. *Epididymitis*, swell'd testicle, gonorrhœal rheumatism, and the two forms of ophthalmia—one an acute purulent conjunctivitis; the other an affection of the deeper fibrous textures of the eye, rheumatoid in character, and allied to gonorrhœal rheumatism—are treated of in other essays.

For the sequelæ of gonorrhœa, such as stricture, spermatorrhœa, warts, &c., the reader is referred to the essays on DISEASES OF THE URINARY ORGANS, of the MALE ORGANS, and of the SKIN.

The *diagnosis* of gonorrhœa is not ordinarily attended with any difficulty. When there is phimosis, the discharge may be furnished from the urethra, or from chancres within the prepuce, or both. We must feel for any localised sore or hardness, examine into the state of the inguinal glands, or wait until, by rest and soothing injections, the prepuce can be retracted.

The diagnosis between gonorrhœa and a primary syphilitic lesion of the urethra so deeply seated as to be undiscoverable upon forced dilatation of the meatus, is difficult, if not impossible. But it has not as yet been proved that a true Hunterian or infecting chancre ever occurs at so great a depth in the urethra; and the diagnosis between a non-infecting sore and gonorrhœa would not be so important.

Treatment of gonorrhœa. First stage. Abortive treatment.—We are met at the outset by a question as to how far this is justifiable. By one party the practice is as loudly vaunted as by another it is utterly condemned. If truth ever rests in extremes, the latter contains the largest measure of it; but the question really lies between the indiscriminate use or abuse of remedies for this purpose, and their judicious application in carefully selected cases. This much may be safely said, that, in practice, it is rare to meet with cases at a sufficiently early stage to justify the use of injections.

When, however, the symptoms are such as have been described in the first stage and no more, the use of astringent injections will no doubt often shorten the progress of the disease.

Spite of the sanction of such names as Carmichael of Dublin and M. Diday, the writer objects to the use of strong solutions as injections, believing them to be incomparably more dangerous and no more efficacious than weaker injections. He is in the habit of using these remedies of a strength and nature such as recommended by Mr. Langston Parker (*e.g.* solutions of nitrate of silver gr. j.-ij. to oz. vj.; solutions of sulphate of zinc gr. iv.-vii. to oz. viij., or diacetate of lead gr. xx. to oz. viij.); and, as far as his experience extends, he has seen no cause to regret their application. Unless the injection be properly applied to the diseased surface no good can result; and the surgeon should do this himself at first, and see that the patient is properly instructed in the method of doing it. Glass syringes, properly selected, or hard india-rubber ones, may be used. The patient should have passed his water a short time beforehand, and be directed to avoid doing so directly afterwards. The distance to which the injection is to penetrate may easily be regulated by compressing the canal at the required point. The injection should be used every three or four hours, and the patient seen at least once daily by the surgeon. Mr. Durham has lately invented a syringe, which throws the injection *outward*; a continuous stream may thus be kept up without any danger of the injection passing too far along the urethra. Some surgeons have reported excellent results from these continuous injections, which may also be applied with a common syringe if the urethra be compressed in front of the scrotum. During treatment the patient should be directed to remain recumbent as long as possible, to live upon a farinaceous diet, and to avoid meat, condiments, coffee, and all stimulants, particularly beer. If the bowels have not been already acted upon, it is right to begin with a purgative, and subsequently to prescribe a

mixture, containing sulphate of magnesia, potassio-tartrate of antimony, and acetate of potass, in sufficient doses to nauseate slightly and relax the bowels without active purging. The patient should also drink diluents of a mucilaginous nature.

The discharge is augmented after the first few hours' use of the injection, and the urine scalds. By about the second day the discharge is perhaps slightly tinged with blood. The injections should then be stopped; but the medicine and precautions as to rest and diet require more than ever to be attended to.

From this period, if the practice is to prove successful, the discharge will diminish, and in about three or four days cease. Should it, however, be diminished, but nevertheless continue, and either no, or very trifling, inflammatory symptoms be present and still limited to the neighbourhood of the meatus, the patient may use a weak solution of sulphate or acetate of zinc. Merely washing out the urethra frequently with tepid or cold water is very useful, inasmuch as the contact of the secretion is in itself a cause of the propagation of the diseased action. If the smarting be such as to render the further use of injections doubtful, these ought at once to be relinquished or replaced by an injection of sub-nitrate of bismuth with a little extract of opium and mucilage. These ingredients act as a local sedative and mild astringent, besides forming a coating to the sensitive mucous membrane. One of the best injections for this stage of the disease is a solution of mucilage and chalk.

Some surgeons in the first stage of the disease give large doses of such anti-blennorrhagics as copaiba or cubebs. This is a practice of which the writer has failed to appreciate the utility, and which he considers dangerous, as in almost every case a good deal of derangement of the digestive system ensues from them, and, not infrequently, symptoms indicative of congestion and irritation of the kidneys.

Second or acute stage.—The first object is to secure perfect rest in the recumbent posture. In practice, unfortunately, this often cannot be done. All exercise should be avoided as far as possible. The genital organs should be properly supported in a well-fitting suspensory bandage.

The diet should be scrupulously low and unstimulating as a rule throughout, to which there are no exceptions at the commencement at this stage. The bowels should be well opened, and during the treatment maintained in a relaxed state. Should the inflammatory symptoms be markedly severe, and out of proportion to the amount of discharge, and at the same time attended with much spasm of the urethral muscles, and scalding in voiding urine, the application of six or twelve leeches to the perinæum affords great relief, although their use is not necessary.

The patient should either not wear pieces of lint over the meatus, between the glans and foreskin, or very frequently indeed change these pieces. The contact of lint soaked with pus is apt to induce balanitis and phimosis, if it have not also an injurious effect upon the urethral mucous membrane, by impeding the exit of the discharge.

Of the local applications, none is better or more soothing than that recommended by Mr. Milton, viz. the application of water, as hot as can be borne, to the genital organs.

The patient should drink frequently barley-water or linseed-tea, to which some mucilage has been added. At this period, saline diuretics, alkaline in character, are almost essential. The writer prefers a mixture of acetate of potass, tincture of hyoscyamus, and nitre, to which a small amount of antimony may be added or not. As soon as the scalding in micturition, swelling of the penis, and urgent symptoms are subsiding, the anti-blennorrhagics may be commenced. Their administration, upon the one hand, before the decline of inflammatory symptoms would be injurious and injudicious; but, upon the other hand, we need not wait until the absence of them in the third stage is pronounced. If the balsam of copaiba be used we need not exceed one-drachm doses, three or four times daily; and half that quantity may be used at the commencement.

One of the most useful forms for the administration of copaiba is that in which the balsam is combined with sulphuric acid. Fifteen minims of dilute sulphuric acid may be added to half a drachm of copaiba with some infusion of roses and

mucilage. The medicine will act with more certainty in this way, will be better tolerated by the stomach, and will not be so disagreeable to the taste.

The administration of copaiba in any form will occasionally be followed by a rash upon the skin. This often causes the patient great uneasiness, as he fancies that he is affected with secondary symptoms. The rash appears suddenly in small red patches, more or less circular, and somewhat resembling the ordinary nettle-rash in character. It never produces any serious consequences, and generally its appearance is followed by diminution of the discharge and other local symptoms. When this rash makes its appearance the use of the copaiba is usually discontinued, and a saline purgative ordered. If it be desirable to remove the eruption speedily, a warm bath will usually accomplish the purpose.

During the inflammatory stage injections are quite out of the question; but if the scalding be not very great, and the lips of the urethra not much swollen, there is no objection to injecting, with great gentleness, a tepid solution of the extract of opium, or, as directed by Bumstead, this, with the addition of glycerine.

The most efficacious plan of treating chordee, when it arises, embraces the following points: to see that the patient has a well-ventilated room, and is as lightly covered with clothes as is consistent with comfort; the avoidance of any supper or drinks for some hours before bedtime, and the use of a hard mattress, to direct the patient, on going to bed to bathe the parts with very warm water, and to continue to do so until a sensation of faintness is induced, if possible. Of the medicines directed to the prevention of this symptom, the best is camphor in a liquid form, as directed by Mr. Milton (one drachm of the tincture in water before going to bed, and a repetition of the dose every time the patient wakes with chordee). Lupulin may also be given, in ten- or fifteen-grain doses, before bedtime. It is less likely to disagree with the patient, but is inferior as a remedy to camphor. Perhaps the most efficacious remedy is, however, a suppository containing a grain of opium and three grains of camphor. This may be made with cocoa-nut butter and used every night.

Third stage.—The most important part of the treatment of this stage consists in the use of injections, at the same that copaiba, cubebs, or other remedies are administered.

Very different opinions have been expressed as to the use of injections. By some it is thought that these are a fruitful source of stricture. There appears to be a certain amount of truth in this opinion: the soldiers treated in Her Majesty's army-hospitals without injections rarely suffer from stricture; while among officers, who use injections to a far greater extent, stricture is not infrequent. This may be only apparent, however; for a structural change in the urethral tunics is the result of some preceding inflammatory process; and the more chronic such morbid process has been, the more likely it is that stricture will result. So far as injections are curative of inflammation, so far will they tend to prevent its occurrence. When by injudicious use they have aggravated or maintained the existing disease, or when they have produced a temporary freedom from discharge, and the patient has been deceived, on this account, into believing himself cured and has acted accordingly, no doubt they may so far tend to the production of stricture.

The writer firmly believes that, when used with ordinary care and judgment, injections are among the very best and most reliable agents we possess for the cure of gonorrhœa.

It is to this third stage of the disease that they are particularly applicable; and the following affords a sketch of the writer's plan of treatment in that stage.

The urgency of the inflammatory symptoms passed, but the entire absence of such symptoms not pronounced, the patient should commence with an injection of bismuth and mucilage (bismuth subnit. xx. gr. to j. oz.), to which a little morphia, extract of opium, or belladonna, has been added. This may be injected thrice daily, and the patient directed to cleanse the urethra also by an occasional injection of cold water. After a few days, this injection is to be exchanged for one of sulphate of zinc (ij. gr. to j. oz.), and the strength of this may be gradually increased to iv. gr. to j. oz. If the case has progressed favourably to a certain extent with this, but then remains

stationary, a variety of injections may be tried, inasmuch as change in itself appears useful. The chloride-of-zinc injection, as recommended by the late Mr. Lloyd, is an excellent one (j.-ij. grs. to iv. oz.) The injection so long in use at the old Lock Hospital, of sulphate of zinc and acetate of lead, xxx. grs. of each to vj. oz., is a very good one. Alum and vegetable astringents are of inferior efficacy. The writer does not commonly use nitrate of silver as an injection; but, if others have been tried, a weak solution (j.-ij. grs. to j. oz.) may be employed.

Recently the sulpho-carbolate of zinc, in the proportion of two or three grains to an ounce of distilled water, has been used, and has proved very efficacious.

The next most important local measure is the occasional use of bougies. The bougies may, before being introduced, be covered by different kinds of ointment or by the balsam of copaiba. The writer much prefers the wax or the metallic pliable instruments for this purpose. An instrument should be selected of sufficient size to adapt itself to the urethra without distending it; and such a one should be passed (with the utmost gentleness) twice or thrice weekly. The writer has obtained excellent results from this combined plan of treatment.

If scalding be present, the bougies should not be used at all; if their introduction induces spasm, the attempt must be made at a later date, or the instrument may be left, as far as it has passed, in the hands of the patient for a few minutes, when it can probably be carried on, without pain, by the most trifling pressure.

As regards medicines, the administration of copaiba or cubebs in some form appears well adapted to this stage.

As stated by Ricord, both copaiba and cubebs seem to undergo some changes in the digestive process which are essential to the development of their curative properties, for injections of these agents are comparatively useless.

It is in the elimination of these agents by the renal organs that they are brought in contact with the urethra and effect a cure.

This was proved by a case in Ricord's practice. A man, the subject of gonorrhoea, had a fistulous opening in front of the scrotum, communicating with the urethra, through which his urine passed. He could, however, close this opening and direct the stream over it through the usual outlet. Copaiba was administered to this patient, and he was directed to pass his urine through the fistula. In the course of a few days the 'running' from this part was cured, that from the anterior portion of the urethra remaining. By passing his urine through the whole canal, the anterior portion was also cured.

The writer has frequently appealed to the experience of the patients themselves as to the effect of different remedies; and the result of his inquiries and personal experience has led him to think that, upon the whole, a treatment embracing the use of anti-blennorrhagic remedies—such as copaiba and cubebs, singly or combined—will be found to yield the best results.

The beneficial effects of these remedies may have been overrated, but experience confirms their influence upon the disease.

The mistakes that are made with reference to the administration of copaiba are chiefly two, viz. the use of the remedy when it manifestly disagrees with, and is not tolerated by, the stomach; and its continuance beyond a certain time where no benefit has accrued from its use. If the patient's digestion be much deranged by the balsam, then copaiba may be prescribed in some other form—in the shape of pills mixed with magnesia, or enveloped with a coating of gelatine (capsules as they are termed). A few days will generally suffice to indicate whether the patient can take the remedy. If his stomach revolts against it, only disgust and injury to health can ensue from its continuance. Cubebs will generally be found to agree and answer well in such cases. The dose of the powder is a drachm thrice daily. Another error consists in the continuance of copaiba or cubebs, without benefit, after about a fortnight. Nothing is more certain than that none will result from their further use under such circumstances.

Sometimes a combination of cubebs and copaiba will be found to agree with and benefit the patient. The diet during this stage may be of a good plain description, without stimulants, unless specially indicated. The more the patient continues in the open air—provided this be without much walking—the better; and the daily

use of a tepid or cold sponge-bath, and friction with hair gloves afterwards, are useful.

As the health will almost surely have been impaired by the amount of discharge, loss of exercise, &c., it is well that some preparations of steel be administered towards the close of the case. Such can be combined with cubebs, or given separately. A combination of strychnia and iron is often very useful. It creates appetite, improves the digestion, and tends to keep the bowels regular rather than confined.

Certain obstacles to success will be met with in different cases. These may be classed under two heads: 1st, local causes. Sometimes the use of injections appears injurious. The patient suffers from pain along the urethra, irritability of the bladder, and sense of weight in the perinæum. Injections must then be discontinued; an alkaline diuretic, with hyoseyamus, and an occasional warm bath, being substituted for them. After waiting for a short time, other attempts may be made with injections of a weaker kind; and here the use of bismuth is indicated. Sometimes the use of injections in any form is injurious. The irritation caused by frequently inserting an instrument within the meatus; the contact of an astringent with the mucous membrane; and the direction of the patient's attention to his disease,—may all tend to protract the disorder or exaggerate the importance of otherwise trivial symptoms. The presence of stricture, or obstruction of any kind, may have to be determined and overcome by appropriate treatment. Sometimes the discharge is kept up by a congested state of the prostatic part of the urethra, and a blennorrhagia of that and neighbouring glands. The treatment will best consist of—Canadian turpentine in ten-grain doses two or three times daily; the passage of a metallic sound greased with a little oxide-of-zinc ointment (one dr. to one oz. of lard); and the use of strychnia and iron. In some cases, where the antiphlogistic treatment and regimen have been carefully attended to, the inflammatory symptoms are of unusual duration, and appear to be unaffected by remedies. This is particularly observed in clear-complexioned persons, or those of sanguine or lymphatic temperaments. In such cases we must adopt an expectant plan of treatment. We may give pil. saponis c. opio night and morning; iodide of iron with sarsaparilla; endeavour to establish a copious diuresis by making the patient drink a tumbler of cold water three to five times daily; use injections of opium or belladonna in glycerine; and let the patient enjoy as much sunshine and fresh air as practicable.

2nd. The obstacles to success arising from constitutional causes, are debilitated states of system, engendered by the disease itself, too much medication, low living, and absence of air and exercise.

The treatment consists in raising the standard of health by every means in our power. How often it happens that a patient's recovery is protracted from over-medication in every way! Change of air and scene; sea-bathing; a tonic regimen (including a glass or two of good port, madeira, or claret); tonic medicines, particularly preparations of iron,—alike establish the general health and tend to cure the local disease.

Blisters have been highly recommended by many, particularly by Mr. Milton; but the writer's experience has not led him to form a high opinion of their efficacy.

Fourth stage. Gleet.—We must remember that this condition is very apt to be due to errors of constitution, such as the strumous, rheumatic, or gouty diathesis, and modify our treatment accordingly. The remarks made in regard to the constitutional remedies in the third stage will apply with more force perhaps to this. The further use of anti-blennorrhagics is needless and hurtful; while the administration of salts of iron is generally indicated. A combination of the tinct. ferri muriatis with tinct. lyttæ is very good. Open-air exercise should be recommended. So that the patient avoids fatigue and riding, he cannot be too much out of doors. Sea-bathing is generally beneficial. We must endeavour to discover what requires amendment or improvement in the system, and act accordingly. Each case will present a physiognomy of its own. It is necessary to bear in mind the tendency which exists to a return of inflammation, or an implication of other organs, such as the bladder, upon the recurrence of exciting causes.

Among the local agents which may be employed with benefit, two are of especial value, viz. the occasional introduction of a bougie, and injections, of which the sulphate, acetate, or chloride of zinc are the best. The application of a small blister to the perinæum may be useful, particularly if the blistered surface be kept open by the use of an irritating ointment.

GONORRHOEA IN THE FEMALE.

Gonorrhœa is a much less common affection in women than in men; and when it does occur, the disease is ordinarily much less severe, and hence more rarely comes under treatment.

A consideration of the very different parts and structures, and the different physiological functions of the female generative organs compared with those of the male, will at once suggest differences in the course and symptoms of this disease in the female. While the urethral mucous membrane is the ordinary seat of gonorrhœa in the male sex, the vagina and vulva are commonly affected in the female. In the male again, gonorrhœa is the result generally of contagion; in the female, vaginal and uterine inflammation and discharges are very common from other causes, and it is impossible to say how many cases in them are the result of contagion, or to diagnose between a discharge the product of gonorrhœal inflammation, or one from other causes. Dr. West says, 'The microscope fails to furnish us with a means of distinguishing between gonorrhœal and simple vaginitis, and no symptom or combination of symptoms is absolutely conclusive on this point.' It is necessary to remember that vaginitis with purulent discharges is common enough in children and young females, from various constitutional and local causes, because such symptoms in adult life often give rise to perfectly unfounded charges.

Gonorrhœa in the female presents varieties, as it is seated in the vagina, vulva, urethra, or uterus.

In the vagina it commences as an inflammation of the mucous membrane, with heat, redness, swelling, and tenderness; and is attended with a secretion at first of muco-pus, afterwards of true pus. Any part of the canal may be affected, particularly the anterior wall beneath the pubic arch; or the whole lining membrane may be involved.

In the vulva the earliest symptoms are, sensations of heat and pruritis; to this a dry and swollen state of the mucous membrane of the vulva and nymphæ succeeds. This stage is very short, and a copious purulent offensive secretion follows. The tumefied state of the parts renders their separation very painful. The various muciparous and sebaceous follicles of the vulva become involved, and pour out a copious secretion. The vulvo-vaginal glands, known as Duverney's or Cowper's glands, situated upon either side of the entrance to the vagina, become engaged, and besides the copious secretion these may yield, they may become the seat of abscess. Mr. Salmon has called attention to cases in which these glands are alone affected. The swollen nymphæ often protrude beyond the labia.

The uterine form is commonly the result of the spreading of the inflammation from the vagina. The canal of the cervix is the part usually affected. The os uteri is red and patulous, hot and tender. By pressure a very tenacious muco-purulent discharge exudes. Erosions and patches of excoriation are commonly present about the os and outer aspect of the cervix.

Gonorrhœa of the urethra very rarely exists alone, but is found in common with one or other of the foregoing affections. The meatus is congested, and the canal swollen and tender; some discharge may be made to exude by pressure applied to the under surface of the urethra against the os pubis, provided the patient has not passed urine shortly beforehand. Scalding is commonly present. The symptoms are less acute than in the male, owing to the shortness and simple structures of the female urethra; the disease also is less protracted, and does not ordinarily pass into gleet.

Complications.—Inflammation of the inguinal glands from gonorrhœa in the female is rare, and almost limited to cases in which the urethra is affected.

Vegetations and mucous patches are not at all uncommon.

Inflammation in consequence of gonorrhœa has been supposed to extend to the cavity of the uterus and to the Fallopian tubes. West mentions two successive attacks of vaginitis at an interval of eighteen months in same patient, which were followed by such severe peritonitis as to call on each occasion for the abstraction of blood.

Ovarian inflammation, corresponding to the epididymitis of the male, occasionally occurs. It has been described by Hunter, Dr. Tilt, and others. It is marked by pain, swelling, heat, and tenderness on pressure in one or other of the iliac fossæ. There is generally pyrexia; sometimes much nausea; and movements of the abdominal muscles are painful. The treatment of this complication will consist in rest in the horizontal posture; the application of leeches to the tender part, followed by fomentations, and the exhibition of saline medicines with opiates to relieve the pain.

Gonorrhœal rheumatism is rarely, if ever, met with in females; and gonorrhœal ophthalmia appears to be uncommon also.

The *treatment* will vary to a certain extent, according to the age and character of the patient, the sthenic or other type of the symptoms, and the stage.

In the acute stage perfect rest, salines, low diet, emollient sedative solutions, and strict attention to cleanliness, are required. Leeches are not advisable, as the bites are apt to be inoculated by contact with the discharges—inflammation and troublesome sores sometimes ensuing. As the disease begins to subside, astringent injections may be used. Sometimes a weak solution of nitrate of silver is very beneficial. These injections should be used four or five times daily, in large quantities, and properly used by means of one of Kennedy's elastic bottles. Pieces of lint steeped in the lotion may also be inserted so as to prevent contact and friction of the apposed surfaces. The exhibition of specifics (copaiba and cubebs) in the gonorrhœa of women is useless, unless the urethra be affected, and even then they seem to be productive of little, if any, benefit.

As soon as the inflammatory symptoms have subsided, the same injections may be used as have been recommended in cases of gonorrhœa occurring in men, such as solution of alum, tannin, sulpho-carbolate of zinc, or acetate of lead, and they may often be used four or five times the strength.

HENRY LEE.

SURGICAL DISEASES OF WOMEN.

THE space allowed by the present work will not permit of anything approaching to a full dissertation on the various affections peculiar to women, which require surgical treatment. I shall therefore endeavour to keep closely to the more important parts of my subject, having regard especially to those diseases which permit of relief by operation.

I. VASCULAR TUMOURS OF THE URETHRA.

Urethral hæmorrhoids, or vascular tumours in the urethra, are not uncommon in women of all ages. They are sometimes single, but often multiple. They may be pedunculated or on broad bases. Their most frequent site is on the floor of the meatus, but they may occur at any part. They rarely extend far inwards, but sometimes sufficiently so to make their complete exposure difficult. Those with broad bases resemble very closely in all particulars the more vascular kind of piles; but those which have become pedunculated are of more fragile texture, and look more like small nævi. They are, however, never congenital, and in their mode of origin and real nature are probably analogous to anal piles. Their symptoms, also, making allowance for difference in site, are very similar to those of piles. Proneness to bleed, great sensitiveness, liability to become extruded and inflamed, pain during the escape of the visceral contents, are some of the symptoms which both diseases have in common.

The irritation and suffering caused by these little growths are often exceedingly great, and may suffice to cause serious constitutional disturbance. In one instance I have known urethral paraplegia to result; but this event is probably extremely rare. The quantity of blood lost may vary greatly, and in some cases, which are yet attended by great irritation, it may be very trivial.

Although these little tumours seem to be very superficial, they are not really so; and unless their submucous base is destroyed, they quickly and pertinaciously grow again. The ligature, excision, and the cauter, either singly or combined, are our chief means of combating them. Whatever method is adopted should be boldly used. The application of any so-called mild caustic, as the nitrate of silver or sulphate of copper, can be productive only of mischievous irritation. The best caustics are the actual cauter or the acid nitrate of mercury; and of these the first is the most manageable. On the whole, perhaps the ligature is the most trustworthy plan. It must be applied by means of a fine tenaculum, by which the base of the tumour from behind forwards is to be deeply transfixed, and over which the silk is applied. If only the crest of the growth be tied, the plan is worse than useless.

II. MALFORMATIONS OF THE VAGINA OR UTERUS.

Cases of closure of the outlet of the vagina by adhesion of the labia in the middle line are not unfrequently brought under the notice of the surgeon. In these the anterior part is almost always open, so that there is room for the escape of the urine. The defect is usually discovered by the mother or nurse early, and the patient comes under care either in infancy or early childhood. At this age the adhesions are rarely strong, and may commonly be broken down by a probe. The insertion of a strip of oiled lint prevents reunion of the edges, and the cure is complete.

In those cases in which the vagina is closed higher up than the external outlet,

the defect is but seldom discovered until menstruation is established. Very frequently the case is allowed to pass on until a large accumulation of retained menstrual fluid has taken place. Amongst the causes which may give rise to closure of the vagina we may class congenital occlusion, imperforate hymen, and adhesion of the walls of the canal consequent on ulceration in early life. The first and the last are much less frequent than the second. If the fact of the existence of vaginal occlusion should come to the surgeon's knowledge prior to the establishment of menstruation, an early operation is very desirable, for even the simplest proceedings, when adopted after menstrual accumulations have taken place, are attended with peculiar danger.

In any case of vaginal obstruction it is desirable, first, to ascertain the character, thickness, &c., of the occluding medium; and secondly, to determine, if possible, whether the uterus be present. In a large majority of cases the existence of an abdominal tumour, consisting of an intra-uterine collection of menstrual fluid, at once sets the latter question at rest.

The determination of the presence or absence of the uterus is in certain cases exceedingly difficult. If, however, the patient have attained adult age, and there have been no menstrual effort, and if on careful examination by the vagina and rectum the organ cannot be felt, a strong suspicion must be entertained that it does not exist. Should there appear good reason to fear that the uterus is absent, and that the case is one of non-development of that organ and of the upper part of the vagina, no operation should be attempted, since any incisions of sufficient extent to clear up the doubt would be attended with much danger.

When there is evidence of the retention of menstrual fluid, and therefore of the presence of the uterus and a vaginal cavity above the occlusion, the case will come fairly under surgical treatment. In the first place, the character of the obstructing medium must be determined. If the obstruction be found within an inch or two of the vulva, and if it be constituted by a membrane, more or less thick and unyielding, stretched across an otherwise well-formed vagina, the case is probably one of imperforate hymen. In some of these, during coughing, the propulsion of the fluid downwards may easily be felt, or the distended membrane may even be forced as low as the vulva. In these cases the operation is in itself easy and simple, though, as we shall see shortly, by no means devoid of risk.

The method of operating in a case of imperforate hymen has usually been to make an incision of a crucial form in the centre of the membrane. A free crucial incision is amply sufficient as regards providing space for all the functions of the tube.

Although, however, the operation in cases of retained menses from imperforate hymen is easy enough, yet clinical experience has shown that it is attended by much danger to life. In a very considerable proportion of such cases, within a few days of the operation, peritonitis comes on and death ensues. This risk is not connected with the extent of the incisions or the nature of the parts incised, for it has occurred in cases in which nothing was done beyond a mere puncture in a thin membrane.

Two suggestions occur by which to explain the danger attending this operation. First, it may easily be supposed that the retained menstrual fluid is in a condition peculiarly apt to undergo decomposition as soon as air is admitted, and not unlikely when decomposed to induce endometritis. The second explanation is one that would scarcely have occurred to the mind had it not been demonstrated by post-mortem observation. It is, that some of the retained fluid finds its way upwards, through the free extremity of the Fallopian tube, into the sac of the peritonæum. That in cases of retained menses the Fallopian tubes, as well as the uterine cavity, are often very greatly dilated, has been repeatedly witnessed.

To MM. Bernutz and Goupil¹ we are indebted for the best collection of facts and arguments bearing upon this subject. In some instances there has been found evidence of ulceration at or near the free extremity of the Fallopian tube, but in others the fluid could only have escaped from the free extremity itself.

These cases illustrate clearly the chief danger to which patients after this operation

¹ See their excellent *Clinique médicale sur les Maladies des Femmes*, New Sydenham Society's translation, vol. i. p. 1 *et seq.*

are exposed. The only explanation which can be given as to why these Fallopian lacerations should be so prone to occur immediately after operations is, that the uterus, by its contractions after evacuation, may possibly drive a certain portion of fluid backwards. It may easily be supposed that the tubes, already distended and thinned, are unable to empty themselves quickly, whilst a powerful organ like the uterus, excited to contraction by the escape of its contents, would rapidly do so, and thus close the apertures of communication.

I am not aware of any published cases of death after incision of imperforate hymen, in which there was post-mortem proof that no escape of fluid into the abdomen had taken place, and it seems probable that this occurrence is the main risk which we have to encounter. The problem, how to obviate it, is one of great difficulty. It is not practicable to avoid such operations altogether; and were it so, as a case published by Dr. Munk proves, no immunity could be obtained. Sooner or later the dreaded event would probably take place. To make a very small incision, and thus allow the fluid to drain slowly off, instead of at once permitting the uterus to empty itself, has been proposed, and with much plausibility. To accomplish this, the introduction of a small drainage-tube by means of a trocar and cannula would perhaps be the best method. Still it is probable that, however slow the escape might be, the uterus would act energetically throughout the whole time, thus preventing the evacuation of the thin and feebly muscular tubes. With the hope of anticipating the dilatation of the tubes, early operations should always be performed in cases of occluded vagina.

The above statements apply to all operations in which there has been retention of menses, whatever may have been the cause. Probably they include the only source of danger to which, in simple cases of imperforate hymen, the patient is exposed. In cases of obliteration of the vagina, however, other risks attend any attempt at operative relief. In these cases the operation is in itself a more or less difficult process of dissection, and there is danger that either the bladder, the rectum, or even the peritonæum itself, may be wounded. No two cases are alike, and it is impossible to lay down rules for the surgeon's guidance, beyond insisting upon the necessity of ascertaining as exactly as possible the thickness of the occluding tissues, and the relative position of the bladder and rectum. It is better to dissect cautiously than to employ a trocar.

The importance of attending to the opening for some weeks or even months after the operation is proved by the fact, that occasionally second operations have been requisite; and in one case, a patient who had survived the first died after the second.

Cases in which the cervix uteri itself is the part which is obliterated occur every now and then, and require surgical relief on account of retained menses. Their management must be conducted on the same general principles as in obliteration of the upper part of the vagina, from which, indeed, it is often difficult to distinguish them.

III. UTERINE POLYPUS.

Attacks of hæmorrhage are by far the most important sign of polypus uteri. Whenever the symptom of frequent and irregular discharges of blood from the vagina is present, and has lasted for some time and resisted ordinary treatment, the surgeon should on no account defer an examination. The speculum as well as the finger should be used. In such cases, if the conjecture has been correct, one of the following conditions may be found: (*a*) a sessile soft growth of small size, containing one or more mucous cysts, consisting of enlarged uterine follicles and hypertrophied cellular tissue; (*b*) a pedunculated growth of small size (a bean to a nut), soft, vascular, and often multiple, consisting of pendulous mucous membrane and analogous to the mucous polypus of the nares; (*c*) a growth of finer texture and larger size than the latter (a nut to an egg), more or less pedunculated, and made up of mucous membrane, with a large excess of cellular tissue; (*d*) a much firmer growth than any of the preceding, and usually a much larger one, either pedunculated or sessile, its attachment usually passing up into the interior of the womb—the common

fibrous polypus (fig. 84). We will omit for the present all varieties of malignant disease, any of which may occasion hæmorrhage, and in rare instances may even form

FIG. 84.—Diagram showing two Uterine Fibroid Tumours, one of which has passed downwards and become a polypus, the other being still encapsuled in the parietes.



growths of somewhat polypoid shape; and also those cases of fibrous tumours in which the growth is as yet embedded in the exterior walls, in which latter hæmorrhage is also a most important sign.

Women of all ages are liable to the development of uterine polypi, but these growths are much more common during the period of menstrual activity than either in very early or in later life. In addition to the bleeding usually caused, we have in most cases leucorrhœal discharge, and more or less of bearing-down pain. The amount and frequency of the hæmorrhage is often diminished when the polypus escapes from the grasp of the cervix; and it also, as a rule, lessens in proportion as the pedicle becomes longer and thinner.

The surgical treatment of small polypi is usually sufficiently easy. They may be removed by scissors, by torsion, by ligature, or by the *écraseur*. In all cases in which the pedicle is long and thin, either to

snip it through with scissors, or to twist it by means of forceps until it gives way, is the best plan. There is little or no danger of serious hæmorrhage. The operation should always be performed with the part well exposed by means of the bivalve speculum.

The position of the attachment of the polypus is of great importance in deciding as to the method of treatment which should be adopted. As a rule it may be stated, however, that all the forms excepting the fibrous and recurrent fibroid are attached low down, either to one lip or just within the cervix. If the attachment is high in the cervix, it may become desirable to dilate the latter by the use of sponge tents.

If a fibrous uterine tumour has become pedunculated and is the source of bleeding, it is the surgeon's duty to remove it. The procedures by which its removal may be effected are three: by ligature, by excision, or by the *écraseur*. A large majority of surgeons of the present day who have had much to do with these cases have recorded opinions adverse to the use of the ligature. If the pedicle be large, the ligature requires some days to cut its way through, and during that time the patient is exposed to the inconvenience and danger of a decomposing mass lodged in the vagina. This source of risk is not chimerical. A large fatality has attended the use of the ligature in the hands of all who have employed it much. Of twenty cases recorded by Dr. Robert Lee, nine ended fatally. This proportion is probably too high; but almost all surgeons will be able from individual experience to attest the fact that deaths do not unfrequently follow its use. Sir J. Simpson and Dr. McLintock of Dublin have both recorded facts and opinions adverse to the ligature. On the other hand, Dr. West states that, of twelve cases in which he practised excision, all recovered without either hæmorrhage or any other untoward symptom; and Dupuytren, Velpeau, and Lisfranc have given similar testimony based on large collections of facts. I am not aware that any cases of fatal hæmorrhage have been recorded. If, however, any fear should still be felt on this score, we have the *écraseur*, by which the gains of both methods may be combined, and the tumour may be taken away at one sitting without any risk of hæmorrhage. It is, however, often difficult to apply.

The operation of excision may be thus performed: The patient should be in the lithotomy position, and the tumour should be carefully brought down by forceps or hooks into the external parts. Not unfrequently its pedicle may be brought almost to a level with the vulva, and then it is easily cut through with scissors.¹ If,

¹ Whenever it is needful to use scissors or forceps high up in the vagina, it is a convenient plan to protect their hinges, &c., by drawing over them a piece of sheet india-rubber, sewn so

however, it cannot be got so low, the scissors may still be quite safely used, and the forefinger of the left hand employed as a guide. Various forms of knives, mostly bent at the end, have been contrived for the special purpose of severing the pedicle in cases in which it is unusually high up. Sometimes, even after the tumour has been detached, much difficulty is encountered in removing it from the vagina. Dr. West mentions that he had been compelled to resort to midwifery-forceps for that purpose; and the same necessity has occurred to myself.

After the removal of a fibrous polypus the stump of its peduncle will wither, and there is no risk whatever of recurrence. As, however, fibrous tumours of the uterus are often multiple, it is very possible that a second may descend and become polypoid. The recurrent fibroid polypus is, like its allied growths (sarcomata) in other parts of the body, very prompt and pertinacious in its return. It is, indeed, difficult, if not impossible, to effect its complete removal.

IV. FIBROUS TUMOURS OF THE UTERUS, IN REFERENCE TO SURGICAL TREATMENT.

It is chiefly in reference to the feasibility of attempting their removal by enucleation that fibrous tumours of the uterus become of interest to the surgeon. Although in many cases these tumours occasion but little inconvenience, and it is not at all uncommon after death to find them embedded in the uterine wall or pedunculated in the abdomen in cases in which their presence had never been suspected during life, yet in other instances they cause constant suffering, and imperil life. The distinction between a 'fibrous tumour' and a 'fibrous polypus' depends solely upon the position of the growth in regard to the uterine walls; and in proportion as the tumour approaches the pedunculated or polypoid form, does its removal become easy. I shall enter at some length into the details of the enucleation process, not from any wish to advocate its claims to more frequent adoption, but because, since in some rare cases it is certainly advisable, it becomes desirable that all the light which can be derived from past experience should be made available. In the 'Medical Times and Gazette' for August 1857, I published, in a tabular form, all the cases of enucleation operations which I could then collect. They amounted to thirty-nine, the greater portion being either ('ontinental or American. Upon the careful examination of these cases the following remarks are based.

First, let me remark that enucleation operations may be conveniently divided into two groups, since in some the intention has been to remove the tumour at the time, in others only to disturb its relations and inflict such injury upon its vitality as to induce its sloughing. By the latter method several operations, after intervals of time, are usually requisite. The former, of course, give us far more serious operations; but in the latter the process is a gradual one, and therefore the risk attending it is protracted over a much longer time. If the indications of the following table may be relied on, it would appear that the gross risk of the two modes is almost equal, and that, under either, about two-thirds of the cases end in recovery. We must examine the comparative merits of the two in a little more detail. Of the thirty-nine cases above alluded to the following is a statistical summary:—

Method pursued	Number	Recovered	Died
Primary enucleations (completed)	18	12	6
Ditto (attempted but not completed)	6	4	2
Enucleation by inducing gangrene	15	9	6

Primary enucleation.—Were certain cases in which enucleation by gangrene has been practised in Edinburgh added to the above table, that method would, it is believed, compare with still less advantage with the primary mode than it now does,

as to form a tube of requisite tightness. In this way only the end of the blades need be left exposed, and there is no risk of folds of mucous membrane getting crushed in the joints, or between the upper parts of the handles.

But the truth is, that the cases in which it was pursued have been, as a rule, much more serious ones than those in the first list. In most the tumour was of a very large size, and either actually embedded in uterine tissue, or at any rate wholly enclosed within the cavity of the womb. Under the head of 'Primary Enucleations,' on the other hand, are included several cases in which the tumour was of small size (less than a pear), and several others in which it was already somewhat polypoid in shape, having been partially extruded by the spontaneous contractions of the organ.

In these, of course, the danger to life would be comparatively but little. Of cases in which the tumour was of considerable size, intra-parietal, and not protruding either into the uterine cavity or the vagina, and in which, consequently, primary enucleation was undertaken under the most dangerous circumstances, we have thirteen; and of these seven ended in recovery, and six in death. In the less serious class, those, namely, in which either the tumour was small in size or already projected considerably, we have ten, out of which only two ended fatally; and of these two, in one the tumour, although projecting into the uterine cavity, was so large that its removal had been found impracticable. It is evident, therefore, that in cases in which the two conditions of moderate size and of somewhat depending position are combined, the operation of primary removal by incisions and the use of the finger is attended by very little danger. In those in which the growth is of large size and completely embedded, the chance of recovery after its removal is about equal to the risk of death. In the largest of all, those, for instance, in which the tumour approaches the size of an adult head, no surgeon would ever dream of primary enucleation. Among the causes of death, we find peritonitis and inflammation of the pelvic cellular tissue to be by far the most frequent. The hæmorrhage, with one or two exceptions, is stated to have been insignificant; and very few appear to have died directly from the shock of the operation.

Mode of performing the operation.—Whoever has either witnessed its performance, or read the detailed accounts given in some of the French narratives, will have no difficulty in admitting that the enucleation of a large embedded uterine tumour is an operation which will tax both the patience and skill of the operator. In not a few on record it occupied between two and three hours in its performance, and presented such obstacles that the operator was repeatedly on the point of relinquishing his task. The circumstance that these tumours not unfrequently occur to single women, in whom the vagina is narrow, often adds to the difficulties of the case. It is of course impossible to give rules which should be applicable to all; but the following memoranda may probably be useful to anyone who may contemplate the performance of this operation.

1st. To have the tumour well depressed into the pelvis by an assistant. 2nd. To let the first incisions be very free, and pass deeply into the tumour, thus not only completely dividing its capsule, but facilitating its bisection, should that afterwards be found requisite. This first incision should be made with a scalpel. In most cases it will be found convenient to pass the knife into the uterine cavity, and then, turning its edge on to the tumour, cut downwards, and either forwards or backwards, according as the mass may occupy either the anterior or posterior wall. 3rd. The capsule of the tumour having been opened, its separation should next be effected by means of the finger, or, if needful, by blunt-pointed curved scissors, the finger being used as a director. 4th. The surgeon should be provided for this part of the operation with a set of curved scissors of various sizes and shapes; one pair at least should be very long indeed. He should also have several pairs of strong and large vulsella, a spatula, a blunt hook, a scoop, and a pair of small midwifery forceps. 5th. The object of the operator, after having separated the tumour from its cyst-wall sufficiently to allow of its lower part being seized, is to invert the uterus, and drag that viscus, together with the tumour, to the external parts. If this be accomplished, the main difficulty of the operation—that, namely, of working in a confined space—is overcome, and a speedy conclusion may be effected. To do this, a large vulsellum should be carefully planted in the mass, and traction, at first gentle, afterwards vigorous, must be exerted. As soon as practicable, a second vulsellum must be

placed above the first, or if more convenient the midwifery forceps may be employed. 6th. After eversion has been accomplished, an examination with the finger in the rectum should be made, and the relative position of parts having been duly ascertained, the remaining attachments of the tumour must be cautiously separated. The utmost care must be exercised not to cut into an inverted pouch of peritonæum. 7th. It is very possible, if the tumour be a large one, that it will be found convenient, before drawing it down, to cut away a portion or portions, and thus diminish its bulk. 8th. It is needless to remark, that throughout the utmost patience must be exercised, and as much gentleness as is consistent with the requisite degree of force. 9th. The operation complete, the everted uterus must be returned; if needed, a sponge plug should be introduced, and a full dose of opium should be given.

Enucleation by inducing gangrene.—This method, if we count those in which primary enucleation was attempted, but could not be effected, and include also a few others not yet on record, has been performed in about 27 cases; out of these there have been about 13 deaths, 10 recoveries, and 4 incomplete cases, in which either it was known that the whole of the tumour had not come away, or there was a return so soon as to render it highly probable that some part had been left behind. Almost all these were cases in which the tumour was of very large size, and in several the operation was undertaken on account of immediate urgency, and after the patient had been reduced to the very lowest stage by hæmorrhage. Thus it appears probable that of cases of this class somewhat more than one-half may be expected to come safely through the risks incident to the procedure, and rather less than half to result in complete cures. It must be borne in mind that a large majority—indeed, almost the whole—were out of all possibility of treatment by the primary method. This plan has the recommendation of being an attempt to imitate nature. Although confessedly very infrequent, yet cases have occurred in which fibrous tumours of the womb have sloughed, and been extruded from their bed without the assistance of the surgeon.¹ A far more common event than this is for them to become pedunculated, and assume the polypoid form, without wholly losing their connections to the uterus. Although but few facts exist on which to ground a positive opinion, yet, judging from those which have fallen under my notice, I suspect that the fatality of the cases in which spontaneous extrusion has occurred has been little less than that of those in which it has been induced artificially.

Removal by laparotomy.—During the last ten years, abdominal section has to a certain extent superseded operations by the vagina in cases of large uterine fibroids. By Mr. Wells, Dr. Routh, Dr. Bantock, and Mr. Lawson Tait some very bold operations of this kind have been performed. The mortality has been high, but with improved methods there are signs of improvement in this respect. The safety of the operation depends much upon whether or not there is any kind of pedicle. It is probably much preferable to secure the latter by ligatures, of which several may be inserted by transfixion, looped together like the links of a chain. This operation (and the same is to be said of hysterectomy) is to be justified only in cases in which the suffering caused is exceptionally severe. There can, however, be little doubt that when, in error as to diagnosis, the surgeon intending to do ovariectomy finds a succulent myoma, it is his duty to proceed to its removal. He will have his choice whether the tumour alone be removed, or the tumour together with the uterus containing it.

The latter operation (*hysterectomy*) has of late years been not unfrequently performed for fibroids. Although an encouraging amount of success has attended it, there can be no hesitation in saying that it ought to be reserved for cases in which hæmorrhage or unusual inconvenience from size or position renders it necessary. In performing the operation the incision is made as if for ovariectomy, and the tumour and the body of the uterus are removed, together with both ovaries if practicable. The line of section may usually pass through the lower part of the tumour or uterine neck. Thus the pedicle will often be bulky and vascular, and it has not been found safe to divide it with the cautery nor after ligature to leave its end in the abdominal cavity. It must

¹ For an interesting example of this, see Mr. Grimsdale's paper in the *Liverpool Medico-Chirurgical Journal*, No. 1.

be secured by means either of an elastic ligature or the wire of a small *écraseur*, and then fixed in the lower angle of the wound. Antiseptics—iodoform, carbolic acid or spirits of wine—must be sedulously employed.

V. CANCER OF THE UTERUS, IN REFERENCE TO SURGICAL TREATMENT.

Malignant disease of the uterus rarely presents itself to our notice in a stage permitting of surgical cure by excision of the cervix. Including in that term the so-called cauliflower excrescence, the epithelial cancer, and the medullary cancer, the remark still applies to all, that they have usually advanced too widely when the surgeon is first consulted, to allow of the satisfactory employment either of the knife or caustics.¹ In a vast majority of cases, all these forms of morbid growth begin at or very near to the os uteri; and if discovered early, would probably admit of removal, in many instances, with benefit more or less lasting. In all, however, the ulceration extends rapidly, and the patient does not submit to an examination until already the vaginal tissues have become involved, or the cervix has been deeply attacked.

It is not by any means an easy matter, in many cases, to make a confident differential diagnosis between a simple or venereal ulceration of the os uteri and one of a malignant nature in an early stage. The tendency of the latter to bleed, its warty and thickened edges, and fetid discharge, are the chief symptoms on which to rely. The surgeon must notice especially whether there be any tendency to new growth, and, if practicable, a small portion of the edge should be removed for microscopic examination. Pain, if severe, is a very suspicious sign. There is good reason for believing that old syphilitic ulcers may occasionally assume a cancerous action. If doubt be felt, it should, if possible, be removed at once, either by consultation with others, or by resort to the microscope; for if the disease be in a stage permitting of removal, it should on no account be allowed further time for extension.

With regard to the diagnosis from each other of the different varieties of malignant disease met with in this locality, no practical benefit can be got from its detailed consideration here. With respect to them all, the question of surgical importance is more as to extent than kind. All, if limited to the lips of the uterus, and if the latter organ be unenlarged and quite movable, should be either removed by operation or destroyed by caustics. If neither of these procedures is appropriate, the only resource left is palliative treatment—the mitigation of pain; the restraining of hæmorrhages, and the lessening of discharge and fætor. Opium, rest in the recumbent posture, and the use of detergent injections (arsenic, Condé's fluid, chloride of zinc, and the like) are the means by which these indications are to be attained. The prognosis of malignant disease of the uterus is most gloomy, despite all that can be done by art to diminish the sufferings which lead on to the inevitable result.

Excision of cancerous ulcers affecting the lips of the uterus (or amputation through its cervix) is an operation which in well-selected cases is not attended by any large amount of risk. Its introduction dates from the earliest years of the present century, when it was largely employed by Osiander of Göttingen, and subsequently by Lisfranc of Paris. Unfortunately, for reasons which we need not state, the large statistics brought forward by the latter surgeon are utterly without value. In this country it has not been very largely adopted, although many surgeons have performed it in isolated cases.

Mode of performance.—The patient should be placed in the lithotomy position, and the thighs well separated. The vagina being opened by the duck-billed spatula, —or, if requisite, by a bivalve speculum—the cervix should be securely seized by long toothed-forceps or books, and steadily but gently drawn downwards. At this

¹ 'Though for the past twelve years I have been constantly looking out for cases suitable for it, but one instance has come under my observation, in which my surgical colleagues have considered it justifiable, and two or three more in which, in my own opinion, it might have been attempted.'—Dr. West's *Lectures*, p. 413.

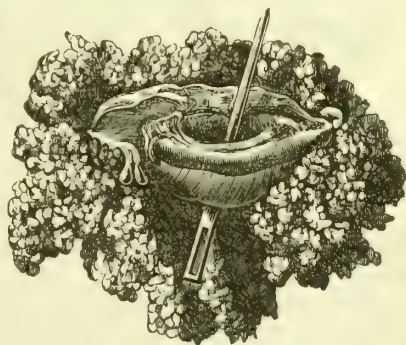
stage it is a good precaution to transfix it laterally, above where it is intended to cut by a needle armed with a wire ligature, the latter to be retained. The uterus having been brought as low as possible, the incisions are to be commenced below, at a suitable distance from the diseased structures, and carried from behind inwards and upwards: then a similar incision is made in front, and carried inwards and backwards so as to cut out a conical portion. In this incision either scissors or knife may be employed. After the section, by means of the wire previously inserted, the stump may be still held in view, both to permit of examination as to whether the disease has been completely removed, and of the application of styptics, should the hæmorrhage make them desirable. It is one of those operations in which the plan of constant irrigation during its performance may be adopted with advantage. The actual cautery and the perchloride of iron ought to be at hand, in case their application may be required. As hæmorrhage may chance to recur some hours afterwards, it is desirable to retain hold of the stump by leaving the wire in, or the latter may be made use of to tie a compress of lint over the bleeding surface.

With the precaution above described the operation of excision by cutting instruments is probably safer and preferable every way to that by the *écraseur*. With the latter instrument the surgeon is not able to adapt his line of incision accurately; the chain must pass horizontally across the entire cervix, and, in order to be sufficiently above the disease at one part, it may be needful to take much more than is necessary at the opposite side. This would be of minor importance if it did not involve more or less risk of including a portion of the peritoneal pouches, which have been drawn down by the back and front parts of the cervix.¹ It is impracticable with the *écraseur* to remove a conical portion, as advised above; and lastly, although this instrument obviates to a great extent the danger from hæmorrhage, it probably increases those from peritonitis and pyæmia. It is for cases of long cervix that the *écraseur* is especially adapted, and precisely in the same is direct excision easy and safe.²

After the amputation of the cervix uteri, whether by scissors or *écraseur*, the patient should be carefully and unremittingly watched for twenty-four hours. In addition to the risk that bleeding may occur, it is possible that a peculiar form of collapse (abdominal collapse of Dr. Barnes) may supervene. Simpson records two such cases, one of which proved immediately fatal, there having been no hæmorrhage or other cause adequate to explain it.

For reasons already hinted at, it is almost impossible to obtain any trustworthy data, either as to the immediate risks of the operation or the average duration of life in successful cases after it. Simpson records in detail one case in which he excised a large cauliflower excrescence (probably not cancer), and the woman at the date of his lecture (eighteen years after the operation) was still in good health, having borne several children in the interval. He seems to be, on the whole, very favourably impressed as to the value of the operation; but he abstains from furnishing any numerical data as to the results he has obtained.³ With the exception of two or

FIG. 85.—Copied from Sir James Simpson's 'Obstetric Works,' vol. i. p. 164. The woodcut represents a Papillary Growth excised in the case referred to in the text.



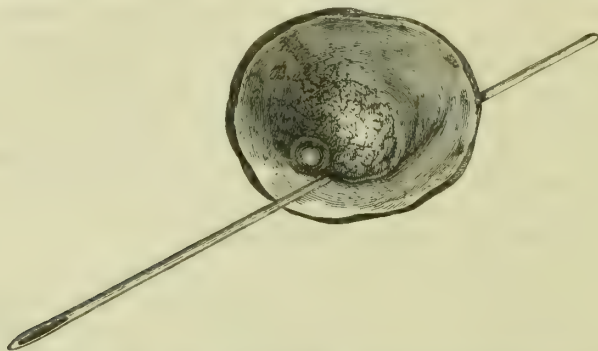
¹ This risk is not imaginary. I am acquainted with a case in which a considerable portion of the peritonæum was thus removed. Others are also on record. See Simpson's Lectures, in the *Med. Times and Gaz.* vol. xviii. p. 105, and Dr. West, *op. cit.* p. 416.

² If the *écraseur* be used, an instrument with a curved end will be found more convenient than a straight one. A strand of twisted wire, as recommended by Simpson, will be better than a chain.

³ The following extracts from his lecture are of much interest: 'I never saw a case which proved fatal by bleeding, or even one where hæmorrhage occurred in any alarming degree.' 'Let me lastly observe, that some patients, but not very many, have died of peritonitis, or that form of surgical fever,' &c.

three cases in Guy's Hospital, the operation has not, I believe, been performed of late years in any of our larger London hospitals. The Guy's cases were, I believe, all successful, but productive only of temporary benefit.

FIG. 86.—Nodule of Cancer in the Scar left by an Excision of the Os Uteri six months previously. The woodcut shows the exact size of the portion removed at the second operation. The probe is passed up the canal of the cervix. From a case recorded by myself in the 'Path. Trans.' vol. viii. p. 253.



If the case be one in which the surgeon has any choice as to performance of excision, he will probably do well to prefer it to the use of escharotics. There are

FIG. 87.—Cell Structures from the Nodule, showing altered forms of Columnar and Ciliated Epithelium.



certain cases, however, in which the disease extends too deeply for a safe excision, where it may yet be fair to employ the former. The best for the purpose is probably the dried sulphate of zinc, as advised by Sir James Simpson. It may be applied either in powder, by aid of a speculum, or made into a paste by means of ointment. Some carbonate of soda, in form of a suppository, should be introduced into the vagina, to neutralise the zinc in case it should run. The potassa fusa is not manageable; but the chloride of zinc may, with care, be conveniently used. The actual cautery is, however, perhaps as efficient, as free from risk, and less painful than any. In many cases in which the cautery has not effected a cure, the patient has yet been

fully compensated for the pain incurred, by the temporary alleviation of symptoms which resulted.

Extirpation of the uterus for malignant disease is admissible only when the uterus is still movable and the disease has not extended to the vaginal walls. It may be performed either per vaginam or by incision through the linea alba (Freund's operation), the latter being probably the preferable method. Its difficulties are not great if the woman be thin, but both difficulties and dangers become increased in proportion to the stoutness of the patient. There is considerable risk of wounding the ureters, especially by the vaginal method; and cases have occurred by both methods in which these important structures have been included in the ligature. When the anterior operation is performed it is desirable in the first place to make an incision per vaginam through the mucous membrane round the cervix, as this will be of great service at a later stage. Having divided the linea alba nearly from umbilicus to pubes, the uterus is to be seized by a vulsellum and drawn upwards and forwards well into view. A needle, armed with No. 4 Chinese silk, is to be passed through the broad

ligament as low as possible, carefully avoiding injury to the ureter and bladder. It is better in many cases to include and remove the ovaries. The sides having thus been securely tied, the next step consists in carefully freeing the uterus from the bladder, cutting through the upper part of the vagina. This having been done, and all the vessels secured, the parts behind are lastly to be divided. It is not desirable to attempt to close the wound, since it is useful for downward drainage into the vagina. There is little or no danger of prolapse of the intestines.

Olshausen has tabulated 41 cases by various operators, by the vaginal method, with 29 recoveries and 12 deaths. This high mortality is the more discouraging when we remember that the operation is performed for a disease which may very possibly return, and that the cures are by no means always permanent.

VI. MALIGNANT DISEASE OF THE EXTERNAL GENITALS.

The chief form of malignant disease by which the external genitals of the female are attacked is epithelial cancer. Sarcoma occurs occasionally, there may in some cases be a certain amount of melanotic growth interspersed, or the disease may begin in a mole, and be chiefly of the latter character. In females of middle age epithelial cancer of the labia, or adjacent parts, is by no means infrequent. The disease presents the same characters as in other parts. An irregular, undermined, indurated edge, an unhealthy grey surface, and a tendency to the production of warty granulations, are its chief features. It is a most formidable disease.

The glands in the groin become contaminated with startling rapidity; and the surgeon's function is then for the most part restricted to attempts at alleviation. In nearly all the cases with the subsequent history of which I am acquainted, speedy recurrence took place. In several of my own cases it was needful to remove also diseased glands from the groin.

Like epithelial cancer of the penis, scrotum, &c. in the male, it is chiefly met with in middle-aged or elderly persons; but may occasionally be found in younger women. Not unfrequently, when it occurs to young adults, it attacks a sore which was in the first instance venereal. This fact must be kept in mind in practice, or an error in diagnosis may result. The one point in respect to the hopeful treatment of epithelial cancer is its early recognition.

Although, as above stated, it is extremely prone to recur after excision, yet, as we possess no other remedy, there can be no doubt that, wherever practicable, the diseased part should be freely removed. In most cases Pacquelin's cautery is preferable to the knife as an excision instrument. If the inguinal glands are at all enlarged, such as are so should be removed also. These operations are rarely dangerous to life, and usually the patient's sufferings are wholly relieved for the time; often a few months of enjoyable life are obtained before the disease recurs. Since therefore in almost all instances they give relief for a longer or shorter period, while there is always a chance that a cure may be obtained, it is without doubt the surgeon's duty to give his patient the benefit offered whenever practicable. If the disease recur, a second period of health and freedom from suffering may be obtained by a second use of the knife. Whether the operation be a primary or a secondary one, it is impossible to exaggerate the importance of doing it early. It is only in the early cases that there is any chance of a permanent cure.

VII. NON-MALIGNANT DISEASES OF THE EXTERNAL GENITALS.

The diseases of an innocent nature to which the external genitals of the female are liable will chiefly find place in connection with other subjects. Chronic induration and enlargement of the labia, clitoris, &c., is most frequently a form of elephantiasis consequent on some venereal affection. It may be convenient, however, to remark here, respecting the removal of these enlargements, that they may for the most part be undertaken with perfect safety. Hypertrophies of the labia commence usually in inflammatory œdema, produced by the irritation of gonorrhœal discharge, or of

mucous tubercles; but when they have advanced to a certain extent, they tend to increase, in consequence of the mechanical impediments to a normal state of circulation presented by their pendent position, and without any reference to their original cause. It is therefore desirable that they should be removed early. When very large, the risk of profuse hæmorrhage is considerable. The bleeding is usually from a multitude of small vessels, not from any single one of considerable size. A good precaution against hæmorrhage is to transfix the base of the pendulous mass by means of harelip-pins before using the knife. Over these pins twisted ligatures may be applied, so as tightly to compress the divided structures and arrest all bleeding. Of course all vessels that can be tied separately should be secured previously to the application of the twisted sutures. On several occasions I have found the latter the only means by which the continued draining from small vessels could be stopped. Excision by means of the cautery-knife (Pæquelin's) is an excellent method, and will usually avoid all risk of hæmorrhage. Of late years I have never used any other.

These tumours consist only of hypertrophied cutaneous structures, and may be developed to a very large size if not removed in anticipation. They may involve one or both labia, the clitoris, or any part of the immediately adjacent integument. It is sometimes needful to bear in mind that their subjects have often also suffered from constitutional syphilis, since, in the after-treatment of the wound, specific remedies may become necessary.

Cystic tumours may be met with occasionally in the subcutaneous tissues of the female genitals. The most common are those formed in connection with the Cowperian glands. They are to be found about an inch or an inch and a half within the vulva, and placed a little below the middle of one or other side of the vagina. They are usually somewhat movable, and non-adherent to the mucous membrane; often very tender to the touch; and rarely larger than a chestnut. When opened, a glairy mucus escapes, often of fetid odour. Their mucous contents may be mixed in greater or less degree with inflammatory products; and sometimes acute inflammation has occurred and dirty grumous pus, of most fetid smell, is the product. For all these conditions the simple measure of treatment is to lay them freely open, and to introduce lint, to prevent premature closure of the orifice. They are more common in young women than in those of more advanced age, and are not unfrequently met with soon after marriage.

VIII. SURGICAL MEASURES IN EXTRA-UTERINE PREGNANCY.

A large majority of extra-uterine pregnancies end in death from internal hæmorrhage within a few months from the date of conception. In some instances, however, the fetus perishes at an early period without rupture of its investiments; and in these, without causing any ill consequences at the time of its death, it may subsequently remain, for indefinite periods, as an encapsuled mass within the maternal organism. In a smaller group of cases neither of these events happens; but the life and growth of the fetus are prolonged to the full period of gestation, at or about which time, however, it inevitably dies. It is these latter cases chiefly which are likely to become of interest to the surgeon, though it is possible that interference may sometimes be indicated at much earlier periods. In rare instances, after rupture of the sac it may be advisable to open the abdomen and clear out the extravasated blood and escaped fetus.

In a case in which an extra-uterine fetus has died at the full period of gestation, and remains lodged in its mother's abdomen, several events may ensue. The fetus may, in the first place, remain without causing irritation, may gradually diminish in bulk, and, having been converted into a mass of adipocere, be carried without material inconvenience to the end of a long life. Many instances are on record in which this has been the course of events, and there is abundant proof that a woman may, even without detriment, pass through repeated pregnancies, with an encysted extra-uterine child still lodged within her. The second possible course is that the fetus may set up irritation, induce suppuration and cause ulceration, either through the abdominal wall, or into the vagina or rectum; and that thus a process of natural expulsion may

be accomplished. A third event, which, like both the preceding, is exemplified in many recorded cases, is that the fœtus may cause such an amount of constitutional disturbance as will be fatal to the mother before there has been time for any process of expulsion to take place.

The questions, therefore, on which a surgeon, who is called upon to decide as to the treatment to be adopted in a case of this kind, will require information, are¹—

1. What is the probability as to the fœtus remaining in a quiescent state, should the case be left to nature?

2. What is the amount of risk that extreme, or even fatal, constitutional irritation may be set up?

3. If the fœtus set up inflammation, and a process of spontaneous expulsion be commenced, what is the prospect as to the mother's surviving it; and what may be expected to be the amount of suffering through which she will probably have to pass?

4. Should the surgeon decide to remove the fœtus by an immediate operation, what is the degree of risk attending such a procedure?

5. Supposing the case to be for the present left to itself, will there occur, at any subsequent time, a suitable occasion for the removal of the fœtus after symptoms of irritation have commenced?

To enable us to reply to the above questions, a very considerable array of cases may be collected, and they are of a character in respect to which the evidence afforded by well-judged statistics may become exceedingly valuable. It is not compatible with the space permitted by the present work to cite the cases themselves; and I am obliged, therefore, to refer the reader who may wish to investigate them more minutely, either to the excellent monograph of Dr. Campbell, or to a series of reports compiled by myself (in large measure from Dr. Campbell's book) and published in the '*Medical Times and Gazette*' for July and August 1860. In the reports in question I carefully collected all the cases I could find published, amounting in total to no fewer than 102. These may be conveniently grouped under the following heads:—

Group A.—Cases in which the fœtus was retained in a quiescent state in the mother's abdomen to the end of her life.—In this group we have twenty-one cases. In three or four instances living children had subsequently been born. The shortest period of the mother's life after the death of the fœtus was four years, the longest fifty-six years. A very much larger number of cases are on record, in which the remains of extra-uterine conceptions were retained for long periods without inconvenience. In most of these, however, there is reason to believe that the fœtus had not nearly attained its full growth, and they have therefore been excluded.

Group B.—Cases in which, without any operation, the fœtus set up irritation, and caused the mother's death.—This group is a very important one, since it contains those in which the natural processes were neither interfered with nor assisted, and in which they proved incompetent to the preservation of the mother's life. In not a few of them it is probable that surgical interference at the proper juncture would have saved the patient. In this class we have thirteen cases. In some, death occurred either during the symptoms of false labour, which usually occur at the time the fœtus dies, and last a few days or a week, or within a short period afterwards. In others the mother lived for a few months after the death of the fœtus, and in one for as long as two years and seven months. In none of the cases counted in this group had any abscess given way externally, but in several inflammation of the sac had occurred, which would no doubt, had the patient lived longer, have terminated in ulceration, and an attempt at spontaneous expulsion. The lesson of these thirteen cases seems strongly in favour of interference.

¹ I have said nothing in respect to the diagnosis, since it is usually not difficult. It may be well to insist on the necessity for great caution before resorting to any operative measures. This caution is especially needful in regard to the subjective evidence furnished by the patient. In one case, in which Dieffenbach was the operator, and the measure was resorted to under the sanction of Dr. Heim, no fœtus was found, and the abdomen was again closed without removing anything. Fortunately in this case the woman recovered.

Group C.—Cases in which ulceration through the abdominal wall took place, followed by escape of the fœtus.—We have in this twenty-nine cases, in fourteen of which no surgical interference took place; whilst in fifteen, subsequent to the abscess having given way, an incision was practised, and the foetal remains extracted by the hand. It will be convenient to call this latter procedure *secondary* abdominal section, to distinguish it from *primary* abdominal section, by which we denote an operation performed prior to the occurrence of abscess. Of the fourteen cases in which nature did all, eleven recovered, and two died; the result in one not being known. Of the fifteen in which secondary abdominal section was performed, in one the result is not known, and of the others all but one recovered. The cases in the next group differ only from these in regard to the position in which the abscess gave way.

Group D.—Cases in which ulceration into the vagina or rectum occurred, followed by expulsion of foetal remains.—In several of these, more or less of surgical assistance was afforded in the extraction of bones, &c., as they were protruded from the cyst into the cavity involved. The group comprises twenty-three cases, of which only three ended fatally.

There now remain for consideration only the last group of cases, in which the surgeon interfered early, abdominal section being performed before abscess had occurred. In some of these the operation was performed during inflammation of the cyst, and when the patient's constitutional symptoms required that something should be done for her relief; in others it was adopted when all was for the present quiet, and with the object of ridding the patient of a burden, or of preventing possible mischief in future.

Group E.—Cases in which primary abdominal section was performed.—In this group we find sixteen cases; out of which six resulted in recovery, and ten in death.

Keeping our attention strictly confined to the question as to the propriety of surgical treatment in these cases, it will be seen that the facts just adduced afford us most valuable guidance. The facts in favour of *secondary* abdominal section are conclusive. No one can doubt that in cases in which processes of suppuration and ulceration have already been set up, it is the surgeon's province to assist in the removal of the decomposing body. The chief point in debate is, therefore, in respect to those cases in which as yet no symptoms have been induced. Let us suppose a woman in perfect health with a dead extra-uterine fœtus retained in her abdomen. She has probably passed the date at which labour was expected by several months, and is quite free from all uterine disturbance; her menstruation being again regularly established. Ought the surgeon, in such a case, to perform *primary* abdominal section; or ought he to advise the patient to let present well alone, and not submit to operative interference until it should become needful? On the one hand is the fact that a large number of cases similar to our supposed one have been followed by no ill consequences whatever, and that their subjects have lived to old age, in some instances becoming the mothers of living children; on the other hand, we have seen that, in a considerable majority of cases, the retained fœtus does sooner or later set up irritation, and, in not a few, of such a severe character as to cause the death of the mother. If no opportunity for surgical interference were likely to occur again, there might be valid reason for urging the immediate operation. But the fact is, as I have shown, that while primary abdominal sections are very fatal, those performed subsequent to spontaneous inflammation are followed by a large proportion of recoveries. The difference between the two operations is very great indeed. In the one, in all probability, a healthy peritoneal sac is laid open; whilst in the other, adhesions having formed, the incision amounts to little more than opening a large abscess. After the one, the decomposing debris of the placenta, the fetid pus, &c., will have access to the peritoneal sac; whilst in the other they are wholly shut off by adhesions. Whoever shall carefully examine the cases to which I have referred will, I think, come to the conclusion that the longer the interval allowed to elapse between the death of the fœtus and the operation for its removal, the less the danger

of the latter. Dr. Campbell regards the operation as not advisable until after 'the system of the parent has been restored to its unimpregnated condition, and nature has evinced a disposition to remove the extraneous mass.' Dr. Parry of Philadelphia, who has recently re-examined the subject, comes to the same conclusion.

As regards the operation itself, little need be said. The tumour should be opened over its most prominent part, and sufficiently freely to allow of the introduction of the hand. Unless the placenta be found detached, it ought not to be removed, but left to come away afterwards. The attempt to detach it might very possibly tear through the cyst, and open into the peritoneal cavity. If no adhesions between the cyst and the parietes be found, the opening in the former should be brought well forward into the wound, and there secured by sutures. The after-treatment should be conducted on general principles, efficient drainage and the use of antiseptics being the most important.

IX. OPERATIONS FOR RUPTURE OF THE PERINÆUM, AND ITS CONSEQUENCES.

Rupture of the perinæum occurring during the passage of the foetal head may vary greatly in its extent. If it involve only a limited extent of the anterior edge, it is of little consequence, and may be disregarded. If, however, it extend backwards through almost the entire length of the structure, there will be great risk that if nothing be done the patient will hereafter suffer from prolapsus of one or other of the pelvic viscera. In a still more severe class of cases, the sphincter of the bowel is also torn through, with the result of incontinence of feces. In all cases except those first mentioned, in which the laceration is trivial, it is very desirable that the rent should be closed. Should opportunity occur immediately after delivery it cannot be done too early. The edges of the tear should be well cleansed, and secured firmly in apposition by deep sutures in the manner about to be described. It is quite possible that the bruised condition of the parts, the presence of lochial discharge, and the state of the patient's health, may interfere with union; but even should they altogether prevent it, nothing will have been lost by the attempt.

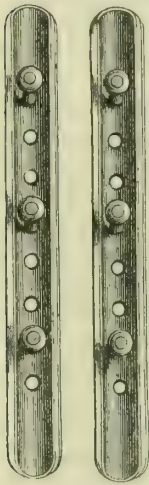
Should no operation have been performed immediately after the accident, or should it have failed to secure union, the patient will probably come under care subsequently, suffering either from prolapsus or inability to retain her feces, or from both. Whether the sphincter ani have been torn or not signifies but little as regards the operation to be performed. It is remarkable that it is as easy to procure union in the more severe as in the slighter cases, and the mode of operating is very similar in both. With regard to the relief of the two classes of symptoms, however it is widely different. If the sphincter ani have been torn through, the patient may be safely promised that an operation for the restoration of the perinæum will be effectual in giving her full control over the lower bowel; but it is impossible to speak so confidently as regards the lesser evil of prolapsus. With respect to the degree of advantage to be expected as to the prolapse, the reports of those who have tried these operations vary considerably. Those who appear to have examined the matter most candidly confess that in not a few cases considerable disappointment followed; and that although benefited for a time, the prolapse subsequently returned. We can have little difficulty in understanding this, if we bear in mind that the severest forms of prolapsus, whether of uterus, rectum, or bladder, are quite compatible with perfect integrity of the perinæum. Other causes, besides want of support below, usually conduce to the descent of the viscera into the vulva. Still there can be no doubt whatever in the minds of those who have seen much of these cases that loss of the perinæum favours prolapse, and that its restoration does much to obviate it. With regard to the degree of benefit obtained, much will depend upon the mode of operating. If, as in some cases on record, the operator contents himself with simply denuding a narrow strip on each side the vulva, and uniting the parts across, a thin perinæum, consisting of little more than integument,

will be the result; and the most that can be expected will be, that what was complete prolapsus may subsequently not amount to more than procidentia. If, on the other hand, the denudation be carried high up into the vagina, and the parts carefully united very deeply, the lower two inches of the canal may be greatly narrowed, and an effectual impediment to the descent of the viscera afforded. Although operations with this object have been performed in England during the last few years by many surgeons, and with considerable frequency, yet but few data are on record by which to estimate the ultimate benefits. I may therefore, perhaps, be excused for referring to my own individual and but limited experience.

Including three cases in which the sphincter ani was also torn through, my operations for restoration of the perinæum, in order to obviate prolapse, have been ten in number. In none did any untoward results occur; but in one no union was obtained. In two or three, to my knowledge, the patients suffered from procidentia more or less during subsequent years. In three others I lost sight of the patients within a few months of the operation, there having been no relapse whilst they remained under observation. In three I can speak confidently as to the permanency of the relief afforded, since I had opportunities of examining the patients several years afterwards. In one instance the patient, an elderly woman, who before the operation suffered from complete prolapsus in a most distressing form, the uterus being swollen and deeply ulcerated, received most signal benefit. I examined her repeatedly during the two years following, and always found the uterus high up in the vagina. She lived six years afterwards; and I was assured by her daughter that up to the time of her death she had remained quite free from her old malady.

The operation for making a new perinæum is conducted on the same plan whether the sphincter ani be torn through or not. The cicatrised edges of the laceration are to be freely denuded, and the parts united by deep quill-sutures. The sutures may be tied over a piece of quill,¹ a piece of bougie, or, what I prefer, a perforated metal bar. I have used those figured in the woodcut in several cases, and found them exceedingly convenient. The wires are brought through the holes and then twisted round the pegs. This allows of any single wire which may appear to be either not tight enough, or too tight, being readjusted with great ease.

FIG. 88. — Perforated Metal Splints, for use in the operation for Ruptured Perinæum.



During the operation the patient should be under the influence of chloroform, and in the lithotomy position. The vagina should be well opened by means of the duck-billed speculum, and a plentiful supply of ice should be at hand to arrest the bleeding. It is desirable to denude extensively, both as regards the length and the thickness of the new perinæum. Very much, as to the degree of relief to the prolapsus, will depend upon whether a good thick cushion is obtained or only a thin cutaneous one. It is desirable also to narrow the vagina for some distance. These important ends are best secured by dissecting up the mucous membrane of the vagina, posteriorly and laterally, for a considerable length upwards. Immediately in front of the rectum the denudation should extend an inch and a half upwards, and from this point it may slant laterally on each side, downwards and forwards, to the point selected as the front edge of the new structure. The dissection should begin from below. Instead of cutting away the flap of mucous membrane, I much prefer to adopt a plan somewhat similar to that of Fricke.² The mucous membrane is turned upwards into the vagina, and the deep sutures are passed, the one nearest to the rectum being introduced into the full depth of the denuded tract—*i.e.* an inch and a half from the surface. The other sutures will pass to less depths, the most anterior one being the shallowest. The flap of mucous membrane is now trimmed at its sides, and is united by wire sutures to the anterior edges of the new perinæum.

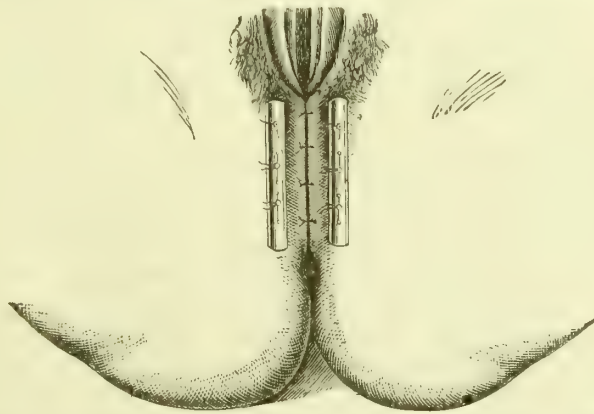
¹ Some operators have recently contented themselves with common silk interrupted sutures, wholly discarding the quills.

² This method of saving the flaps was fully described by me in the first edition of this work (1864).

It thus slopes forward, covering over the deep surface of the newly united parts and extending their whole length. This flap is nourished by its attachment above to the vagina, and, according to my experience, there is no risk of its sloughing. I believe that it materially favours union by preventing vaginal discharges from gravitating into the wound; and it also greatly thickens and strengthens the new perinaeum. Of course, when the rectum is torn high up, a central flap cannot be obtained; but we should still, in these cases, save as much as possible of the lateral ones. The parts should not be closed until the bleeding, which is often rather free, has a good deal diminished. Some operators have insisted strongly on the importance of freely dividing the sphincter ani; and in cases in which the laceration extends high into the bowel, this measure is undoubtedly important. In cases in which the sphincter has not been torn, it is certainly unnecessary to divide it; and even in some in which it has been so, excellent results may be obtained without.

In the after-treatment the bladder should be kept empty and the bowels relaxed. The sutures should not be removed until the tenth or twelfth day, and, however sound the union, the patient should be made to keep her bed for at least three weeks.

FIG. 90.—The Perinaeum, after coaptation by deep sutures, &c.



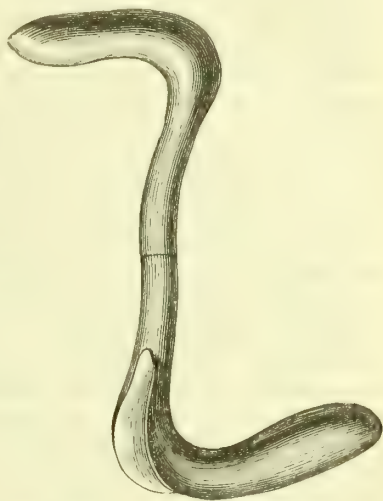
The recumbent posture made necessary by the operation is, no doubt, an important part in the cure of the prolapsus for which the operation is often performed. It allows time for a swollen and, perhaps, ulcerated uterus to diminish in bulk and weight, and for its stretched ligaments to shorten.

Prolapse of uterus.—Operations having for their object the relief of prolapse of the uterus in severe cases by the method of narrowing of the vagina, were performed by Mr. Baker Brown, and have more recently been advocated by Professor Le Fort and others.

X. ORGANIC DISEASES OF THE OVARY.

The organic diseases of the ovary and adjacent parts may be thus classed:—1, Simple and single cysts; 2, multiple cysts; 3, proliferating cysts; 4, dermoid cysts; 5, cysts of Fallopian tube, broad ligament or parovarium; 6, solid fibroid

FIG. 89.—A modified Duck-bill Speculum: the most convenient form for vaginal operations. (Pratt's modification of Sims'.)



growths; 7, solid malignant growths. It will be convenient to say a few words respecting each, beginning with the last.

The fibrous growths of the ovary are decidedly rare, perhaps much more so than is supposed. They may in some instances attain very considerable size, and may even approach that of a pregnant uterus; more usually they are much smaller. Their substance is made up of dense fibrous tissue, which replaces the stroma of the organ, and by which the latter is at length wholly substituted. During life it would be difficult to diagnose with any certainty between a fibroid tumour of the ovary and a similar growth from the uterus (if detached and pedunculated); but as the rule of treatment is the same for both, but little practical importance attaches to the question. In both it is desirable to give a fair trial to the bromide or iodide of potassium, or to some natural water holding haloid salts in solution (Kreuznach, &c.) These salts are to be recommended, not so much in the hope of inducing any absorption of the tumour, as of repressing its vitality and arresting its further growth. Solid tumours occupying the abdomen, whether originating from the ovary or the uterus, and whether believed to be innocent or malignant, should as a rule not be interfered with. If innocent, they rarely cause death, and at a certain period of life almost always begin to shrink; whilst any attempt to remove them by abdominal section is attended by great danger.¹ If malignant, the reasons against their removal, or rather against the attempt at it, are manifold and apparent. The form of cancer most frequent in the ovary is that known as alveolar, or colloid, and the tumour thus constituted is cystic rather than solid. In rare instances, however, medullary cancer occurs as a primary disease in the ovary, and a very large tumour may be thus developed.

Cystic disease of the ovary.—This disease may present itself in two forms, the *simple* and the *proliferous* cysts; but the two are very closely allied, and the former may at any time assume the characters of the latter. Again, we must note that the proliferous or compound cysts differ much amongst themselves in the degrees in which their peculiar endowment is developed. Some show but little tendency to reproduction, whilst others exhibit the utmost activity. There is good reason for believing that the simple cysts of the ovary are developed by the dropsical dilatation of Graafian vesicles. Not unfrequently more than one is formed in the same ovary; and at later stages the partitions between them may be broken down, and a single irregularly chambered cavity may result. Simple cysts may attain a very large size, but the compound ones, as a rule, exhibit yet greater activity of growth. The *compound* or *proliferous* ovarian cyst is by very far the most frequent form of ovarian dropsy, and is closely homologous to the cystic diseases of the breast and testis, allowance being made for the different structural peculiarities of these organs. It is probable that the morbid action usually commences in the stroma of the ovary, but it may in some instances originate in the Graafian vesicles. With regard to the contents of ovarian cysts, it may be stated to consist of an albuminous fluid of greater or less density. In simple cysts the fluid is usually thin, but in compound ones it varies from the consistence of a dilute solution of gum-arabic to that of stiff glue. In the latter it often varies very greatly in different cysts composing the same tumour. In colour it also presents great varieties, from a clear watery fluid to a dark tar-like one. It often contains sparkling scales of cholesterine in immense quantities. In rare instances ovarian cysts contain a sero-purulent fluid, or even pus. This is more common in simple than in compound cysts, and usually is a consequence of inflammation after tapping. The term ‘alveolar or colloid cancer’ has been applied to a not very infrequent variety of compound cyst of the ovary in which very numerous

¹ In these remarks it is intended to include only those tumours which have passed upwards into the abdominal cavity and become pedunculated. Uterine fibroids still occupying the walls of the uterus are treated of elsewhere (see p. 397 *et seq.*) It must be always remembered that the dangers of abdominal section for solid tumours far exceed those of ovariectomy. As the tumour cannot be diminished by tapping, the incision must be very free, whilst the peduncle, if it exist, is certain to be short, thick, and very vascular. Of late years, however, many such tumours have been successfully removed.

loculi exist, and the spaces are filled by a semi-solid tenacious substance resembling gum. This variety, however, not unfrequently complicates tumours in which many cysts contain fluid and resemble those of the common compound form. There is much reason to doubt whether the usual tendencies of true cancer are ever manifested by it. Again, we must note that compound ovarian cysts differ not only in respect to the density of the contents, but also in the thickness of the intervening solid substance. Müller has applied the designation of *cysto-sarcoma* to those in which the fibrous intercystic substance equals or exceeds in quantity the contained fluid. Here, again, however, all degrees may be observed in different tumours, and even in different parts of the same tumour, and we cannot therefore venture to separate abruptly ovarian cystic tumours into different classes. Good typical examples of all of them—*a*, the simple, single cyst; *b*, the simple but multiple cyst; *c*, the proliferous or compound cyst; *d*, the proliferous or compound cyst with colloid contents; *e*, the proliferous with large sarcomatous formation—may frequently be met with; but in a large majority of instances ovarian tumours share the characters of two or more of these varieties. The more active the proliferous tendency, the further the departure from simplicity of organisation, the more nearly does that tumour approach in its relations to malignancy. Whether, however, any form of ovarian tumour, excepting the fungoid (medullary), is truly cancerous in its tendencies, is a matter of much doubt, and practically all must be treated as if it were proved that they are not so.

There is yet another variety of ovarian cyst to be mentioned, that, namely, in which a structure resembling the cutaneous integument (both in structure and function) is formed. These, known as *dermoid cysts*, possess the power of producing in their lining membrane all the appendages of the skin—hair, teeth, &c.—and of excreting into their interior the ordinary secretions of that structure. Thus not unfrequently teeth, balls of hair, or large quantities of fat are found in them. Plates of bone are also sometimes met with, and the presence of these may occasionally be recognised before the operation and thus lead to a definite diagnosis. Dermoid cysts usually complicate other forms of ovarian tumour, and they have been frequently removed with success. Mr. Wells gives interesting details of a series of cases which occurred in his practice (see page 69 *et seq.*) They may be met with at all ages, even in infancy.

Cyst formations not actually in the ovary itself may present considerable variety as to the precise place of origin. They may occur in the broad ligament from dilatation of the tubes of the parovarium, or from expansion of the bulbs of the Wolffian organ. They usually remain of small size, and are discovered only by accident. In some cases, however, parovarian cysts may enlarge so as to fill the abdomen. They are usually attended by less constitutional disturbance than is present in true ovarian tumours, but the diagnosis can be at best conjectural until the operation is performed. They not unfrequently present the condition of entire absence of pedicle. A yet more rare form is that in which the cyst is formed partly in the substance of the ovary, and partly by dilatation of the Fallopian tube. These tubo-ovarian cysts may attain large size, and have the peculiar clinical feature that it is possible for them to empty themselves into the uterus and to disappear without risk to the patient. Mr. Wells has recorded some cases in which this took place after the cyst had attained a size sufficient to suggest the necessity for operation.

With regard to the relative frequency of the different forms of ovarian disease, Dr. West supplies us with the following data: of a total of sixty cases, forty-one recorded by Scanzoni and nineteen by himself, simple cysts occurred in fifteen; fat-cysts in one; compound cysts (with *cysto-sarcomata*) in twenty-three; colloid or alveolar in nineteen; cancer with cyst-formation in two.

Post-mortem examinations prove that the two ovaries are equally liable to disease. In a not inconsiderable proportion of cases both organs are affected together.

Ovarian disease may occur at any age, from infancy upwards. It is of tolerable frequency during the whole period of sexual activity, but most so during the latter

half—*i.e.* from thirty to forty-five. It is very rare in childhood,¹ and decidedly infrequent after the complete cessation of the menstrual function. It is relatively more common in single than in married women, and of the latter a large number have either been sterile or have manifested but feeble fecundity. Beyond this latter fact nothing can be asserted as to the causes of ovarian disease.

The *rate of growth* of ovarian tumours is subject to considerable variety. In the majority of cases, in from two to three years from the commencement, or at least from its first discovery, the tumour will have become large enough to fill the abdomen and produce inconvenience by pressure on the viscera. In many the rate of progress is much more rapid; in a few, and especially in the aged, it may be much slower. Beyond the stage described, we are not able easily to ascertain the average natural progress of ovarian tumours, since in a great majority of instances one or other mode of treatment is adopted as soon as the dropsy becomes a serious inconvenience. Such facts as are on record, however, do not encourage the hope that in patients under forty ovarian disease, not interfered with, may frequently be protracted over many years. As soon as the abdomen is distended, the patient's health begins to fail, the process of assimilation is interfered with, exercise is prevented, the demands of the tumour are a drain upon the patient's strength, and she becomes rapidly thinner and more feeble; the tumour still grows, the lower limbs become cedematous from pressure on the veins, the thorax (both ribs and diaphragm) is displaced upwards and fixed, rendering respiration difficult and incomplete;² the patient ceases to be able to lie down, and, after a most painful illness, death at length puts a period to her sufferings. That the latter stages of ovarian dropsy should be prolonged over months instead of weeks would be a matter of regret rather than congratulation. In addition to the ills above mentioned, intercurrent attacks of peritonitis are common in the course of ovarian dropsy, and not very unfrequently spontaneous inflammation of the interior of one of the cysts takes place. Either of these occurrences may very seriously reduce the health of the patient, and the latter may prove directly fatal.

Before proceeding to consider the different surgical measures by which relief may be afforded, we must refer to the possibility of *accidental or spontaneous cure*. It is probable that now and then an ovarian cyst may, without having ruptured, spontaneously cease to secrete, and become greatly diminished in size. This termination has, I think, been illustrated in one case under my own care; but there can be no doubt that it is an exceedingly rare one. The rupture of the cyst, either by violence or by ulceration, into an adjacent viscus is much more frequent, and numerous cases are on record in which cures have been brought about in this manner. Notwithstanding an occasional cure so produced, however, the internal rupture of an ovarian cyst is scarcely an event to be desired. In not a few the death of the patient is the immediate consequence, whilst in others recovery only results after severe peritonitis and a dangerous illness. It is of course only in cases of single cysts that any permanently satisfactory result is to be hoped for, and even in these the probability is great that, after the rent has closed, re-secretion of the fluid will follow. If, instead of rupture into the peritoneal sac, the tumour have ulcerated into the bowel or vagina, all the dangers incident to inflammation of the cyst-cavity will probably be encountered.

We may, then, safely allege that ovarian dropsy is, as regards any probable process of natural and spontaneous relief, an incurable disease. Further than this, we may safely add that, putting aside certain exceptional cases met with chiefly in aged patients, it is a disease which, within from one to three years of its commencement, may be expected greatly to incapacitate its subject for the ordinary enjoyment of life, and at the end of one or two years more to end fatally, after extreme and protracted suffering. In this statement of clinical fact we have the measure of

¹ Kiwisch alludes to a specimen of cystic disease of the ovary from a child aged one year. I have myself seen a large ovarian tumour in a girl of twelve.

² See plates, by Dr. Bright, in *Guy's Hospital Reports*, vol. ix., or in New Sydenham Society's reprint, p. 90, plate 33, and p. 122, plate 36. See also Mr. Wells' book.

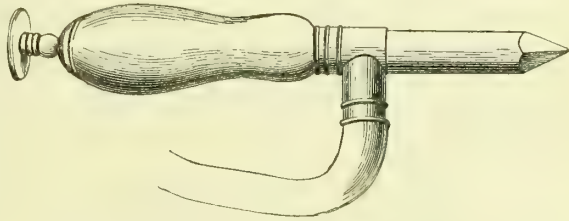
the value of surgical methods of relief. To these latter the reader's attention is now asked.

In former editions of this work I discussed in detail the methods of treatment in vogue before the final triumph of ovariectomy, but it is now scarcely worth while to do more than mention them. They have become for the most part matters of history. Those who wish to know more of the plans formerly tried in the hope of procuring complete cure of ovarian dropsy without encountering the supposed dangers of extirpation of the tumour, must refer to the original edition of this essay. The following methods are there described: 1, By repeated tapplings; 2, by pressure after tapping; 3, by the use of mercury; 4, by injections of iodine; 5, by the establishment of fistulæ. Of late years these have all been wholly disused.

First, let it be remarked that no impression can be more false than that the extirpation of an ovarian tumour is a procedure requiring but little surgical skill or forethought, and making demands only upon the surgeon's courage. Perhaps there is no operation in surgery presenting greater scope for ingenuity, and requiring more prompt attention to numerous details in its performance. Hence the remarkable success which has attended the operation in the hands of specialists as compared with that of other surgeons.

The operation.—In preparation for ovariectomy, the surgeon should be provided, in addition to scalpels, director, &c., with at least two large trocars, one of them armed with an india-rubber tube, two or three strong vulsellum forceps, half-a-dozen bulldog forceps of Wells' pattern, cautery instruments, some gilt harelip-pins and silver-wire sutures, and strong hemp ligatures. Some strips of new flannel, and several large unused sponges, made soft by scalding, should also be at hand. The operation

FIG. 91.—Trocár, armed with tubing, for use in Ovariectomy.



should be performed in the room where the patient is to remain, and it should be a large and well-ventilated one. If the weather be not hot, the temperature of the room should be raised to 70° or 75°, and the air moistened with steam. With regard to special preparation of the patient, nothing is needful beyond the ascertaining that her bowels have been opened on the previous day, and that she is in usual health. As the operation may be prolonged, she should be warmly clad on those parts which it will not be requisite to expose, and precautions should be taken to prevent her dress from being wetted by the fluid. An anæsthetic having been administered, an assistant should introduce a catheter and empty the bladder. The patient should be placed on her back with her shoulders elevated by pillows, her feet resting on a chair and the abdomen well exposed. The operator now commences his incision about two inches below the umbilicus, and carries it downwards in the median line about four inches. With a few touches of the knife, and using the director or not, as may seem best to him, he rapidly divides the fascia and lays bare the peritonæum. There is rarely any bleeding if the median line be carefully kept to. The peritonæum having been opened to nearly the full extent of the wound, the cyst itself is exposed, and at this stage in many cases a certain amount of ascitic fluid escapes. The next step is to ascertain whether or not adhesions are present. It is needful to be exceedingly careful not to mistake the peritonæum itself for the cyst-wall, and thus carry the finger between it and the transversalis fascia—an error which has not unfrequently occurred. If adhesions exist they must be cautiously broken down, and for this purpose it may be necessary to introduce the entire hand. For several reasons it is desirable to break down the adhesions, as far as practicable, before tapping the cyst. Whilst the cyst is full, it supports the parietal peritonæum, and prevents risk of its detachment by the traction necessary to tear them through:

its pressure also diminishes the risk of bleeding. The operator—having ascertained that the cyst has no adhesions in front, or the adhesions, if present, having been broken through—next introduces a large trocar into the most prominent part of the cyst. As the fluid escapes, the abdomen should be carefully compressed by assistants. When the tumour is three parts emptied, the operator may seize it with a vulsellum, and drag it forward carefully, at the same time attending to the trocar, that no fluid is allowed to run back on the wound. As the remaining fluid escapes, the cyst is gradually drawn out until it is wholly delivered. A piece of flannel, from warm carbolised water, is now placed over the wound, the edges of which are held closely together by an assistant. The operator examines the pedicle, and secures it by ligature. The tumour is next cut away, and the pedicle, where cut, having been carefully examined, is dropped back into the abdomen. With as little delay as possible the external wound should now be closed; the surgeon having, however, previously ascertained the state of the other ovary. The wound may be closed either with harelip-pins or by strong sutures, and these may be introduced either through the entire abdominal wall, including the peritonæum, or through its whole thickness, with the exception of the latter. They should be an inch and a half from the edge of the incision on each side, so as to have a firm grasp. They should not be more than three-quarters of an inch apart. Broad and long strips of plaster should now be applied and covered by a compress of iodoform lint, over which a large mass of cotton-wool may be placed, and a four-tailed flannel bandage firmly applied over all. The patient should be returned to a warmed bed, and a suppository of two grains of opium may be introduced into the rectum. As a general rule, there will be no need for the administration of stimulants; but should the patient be faint, a little brandy may be given as an enema.

The *after-treatment* must vary according to the special symptoms which may present themselves. 1st. It is very desirable, in order to avoid vomiting, that the patient should take nothing by the mouth during the first twelve hours excepting a little ice; above all, no opium or other medicine should be so given. 2nd. There is reason to believe that formerly the chance of recovery in many cases was much diminished by the too hasty and too free resort to opium and stimulants. The surgeon should watch carefully, and give or withhold these remedies as the patient's state may demand. In not a few cases neither the one nor the other will be necessary. 3rd. If the patient be low, she should be nourished by enemata of milk or beef-tea, to which, if needful, wine or brandy may be added. 4th. If the stomach remain irritable for some days, it is desirable, as long as such is the case, to continue the use of enemata instead of giving food by the mouth.

Traumatic peritonitis is, without doubt, the chief cause of death after ovariectomy. It may commence within a few hours of the operation, and many patients sink from the shock of its initial stage. Many of the deaths attributed to 'exhaustion' have, in all probability, been really due to commencing peritonitis. In those cases which wholly escape peritonitis the recovery is usually rapid; the patient, in fact, scarcely experiencing a single ill symptom. The earliest *signs* of peritonitis are pricking and shooting pain in the abdomen, a peculiar pallor of the cheeks,¹ and an anxious expression of countenance, with frontal headache. The pulse becomes quicker and smaller, the skin hot, the tongue a little dry, and there is almost always more or less sickness. Sometimes the patient scarcely complains of pain, excepting what is caused

¹ In florid patients, the face may from the first be flushed instead of pale, but I feel sure that pallor is its most frequent condition. In some of the most severe cases of traumatic peritonitis which I have seen, the patient looked in the early stage as pale as if she had been profusely bled. I have not mentioned rigors as an early symptom. Peritonitis may set in without any marked shivering fit; sometimes a slight feeling of faintness, which rapidly passes off, and then returns again, appears to take the place of a true rigor. Later in the case, after the peritonitis is well established, occasional shivering is rarely absent, but, at the same time, it is not often severe. It has been customary of late years to allege that septicæmia is the chief cause of death after ovariectomy. The septicæmia is however, I suspect, never primary, but always induced by peritonitis; whilst, on the other hand, it is very probable that the peritonitis is usually due to some septic poison introduced at the time of operation.

by the shake of vomiting. At a later stage the face may become flushed, and the skin pungently hot, whilst at the same time the pulse is rapid and very small. The concurrence of a very hot and dry skin with a thready, scarcely perceptible pulse, may be observed now and then in severe cases, and is a sign of most evil omen. Distension of the stomach with flatus is a common and distressing symptom, and at a later stage the intestines also become involved, and the abdomen is full and tympanitic. The *treatment* of peritonitis will be local and general. Locally it is well in the first instance, indeed as early as possible, to apply leeches freely, and these may be followed by a large hot poultice. The relief afforded by a large linseed poultice covering the whole abdomen is often very decided. On the other hand, the application of ice has its advocates, and it would not be difficult to explain how both heat and cold may each be beneficial. Venesection may in certain sthenic cases be resorted to with advantage. Opinions differ widely as to whether mercury is of benefit in traumatic inflammations; my own impression is very decidedly in its favour; and in early stages of the disease I should be inclined to push it freely, in combination with full doses of opium. The practice, too often pursued, of pouring in stimulants is not one to be recommended, either on theoretic or clinical grounds; but the patient must be most carefully watched, for remedies of this class will undoubtedly become necessary at a subsequent period.

With regard to the management of the wound there is little to be said. Union is usually immediate. The harelip-pins or deep sutures should be left to the fourth or fifth day; and when they are removed, the greatest possible care should be taken to support the abdomen and wound by long and broad strips of plaster, and the firm application of the flannel bandage.

In a successful case of ovariectomy the patient will often be able on the second day, or it may be even on the first, to take food by the stomach without risk. In no a few the progress of recovery is as rapid as it usually is after a favourable childbirth; and the patient may be able to leave her bed on the tenth day, or from that to a fortnight or three weeks. If, however, peritonitis have occurred, the convalescence will be much delayed.

Having thus sketched briefly the course of an ordinary operation, and the after-management of the patient, there yet remain certain occasional difficulties and moot questions of treatment which demand more detailed consideration.

Is the long or the short incision preferable?—There has been much confusion in the description of cases as to which should be assigned to one or the other category. The distinction is mainly arbitrary. Should the incision be measured before the removal of the tumour or afterwards?—for one which would be considered long whilst the abdominal walls were distended might count as short when they had contracted. Experienced ovariectomists are, I think, all agreed that a few inches more or less in the length of the wound do not constitute an important element in the chance of recovery.

Adhesions.—I have already insisted on the importance of detaching adhesions as much as possible before the fluid is evacuated. Not unfrequently, however, the more important adhesions are found behind the cyst, uniting it to the viscera, or to the lumbar or pelvic peritonæum. These cannot, as a rule, be safely reached until the cyst has been emptied. In separating these, great care must be taken not to drag too forcibly on the peritonæum. Not only may injury be done by tearing up the serous membrane from its attachments, but lacerations of viscera or of large vessels may occur. It is better, under all circumstances, to tear rather than cut; but when important viscera are involved, such as the intestines or gall-bladder, it may become needful to resort to a careful dissection.

That the existence of adhesions to a moderate extent does not materially prejudice the patient's prospect is generally admitted. There seems to be less danger of acute diffuse peritonitis in such cases than in those in which the integrity of the serous sac has never before been interfered with. On the other hand, adhesions prolong the operation and cause risk of hæmorrhage, and in these respects are prejudicial. If very extensive or very strong, they may constitute a serious complication.

Adhesions to the omentum are very frequent, but are for the most part easily dealt with. If very vascular, the omentum may be tied, and the end dropped into

FIG. 92.—Clay's Adhesion Clam.



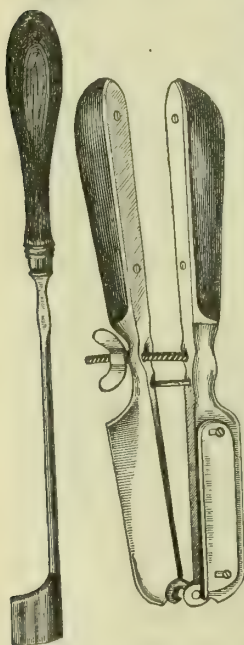
the abdomen. Dr. John Clay has devised an 'adhesion clam' for holding bands of adhesion whilst they are cauterised or rubbed through, &c. The plan usually adopted in the present day is, however, to compress all adhesions for a

time by forceps, or to twist them, and if these measures do not at once stop bleeding, to tie with catgut or carbolised silk and cut it off close.

Multilocular cysts.—The operator should always be provided with at least two trocars, so that he may, if needful, puncture any second cyst which may present itself. If the cysts be very numerous, and many of them of considerable size, it may greatly expedite the operation to cut freely into the largest with a scalpel, and then introduce the hand into the interior, and break down their dissepiments. Of course before this is done the cyst should have been partially withdrawn and secured, and the patient placed well over on her side. Or, instead of making a large incision into any one of them, the tumour may be dragged forwards, and each single one punctured individually as they appear in the wound.

Prevention of escape of cyst-fluid into the abdominal cavity.—This is of great importance. No single precaution is, I am convinced, more effectual in securing

FIG. 93.—Clamp and Cautery-iron for cauterisation of the pedicle in Ovariectomy. The blades of the clamp are partly of wood and in part of metal.



it than that of turning the patient over on her side. By this means a depending opening is given by which the fluid may escape, and the chance of its gaining access to the peritonæum is very greatly lessened.¹ The patient should be turned over to that side on which the intestines are supposed to lie—i.e. with that side uppermost from which the tumour is believed to originate. If by any chance cyst-fluid have escaped into the peritonæum, it should be removed with scrupulous care. A piece of soft scalded sponge is better for the purpose than flannel.

Management of the pedicle.—Although ovariectomists appear to be now well agreed that it is the best plan to drop the divided pedicle back into the abdomen, they are not unanimous as to the method of its division. Some (Dr. Keith amongst them) prefer division of the pedicle by the cautery, whilst others advocate the use of the ligature (fig. 93). If the latter plan is adopted, the following details are to be attended to: the ligature is to be of Chinese silk, an animal substance which is capable of easy absorption; No. 3 or 4 will usually be stout enough. In some cases it may be practicable to secure the pedicle in a single loop, but more commonly it will be preferable to transfix it and tie in two halves; often it must be divided into three, and now and then even into four. Whenever more than one loop is used, the operator must be careful, in order to avoid tearing of the structures, to link the different loops together. The tumour should be removed at such a distance as to leave a good half-inch of pedicle on the distal side of the ligature. If this be not done, the ligature may slip, and hæmorrhage occur. In order to avoid error the operator must make careful allowance for the fact that in most cases the pedicle is on the stretch at the time of tying it.

On the causes of increased success in ovariectomy during recent years.—The explanation of the success which has attended ovariectomy during the last twenty

¹ Mr. Spencer Wells has devised an ingenious and useful appendage to the ordinary cannula, by which the slipping of the cyst is prevented. It consists of toothed springs, which clamp the cyst firmly to the sides of the cannula.

years, as compared with what was the case previously, is by no means difficult. It is not to be assigned to any one improvement of practice, but rather to painstaking attention to details in many. In one important point at least, a change which seemed to be a great improvement, and which held its ground for many years, has finally been relinquished in favour of the practice of former times. The extra-peritoneal method of dealing with the pedicle appeared to be based on the sound surgical principle of keeping tissue which had been ligatured, and which might possibly slough away, from contact with the serous membrane; but it has now been universally abandoned in favour of the plan of dropping the tied end of the pedicle back into the abdomen. Experience has shown that with proper attention to cleanliness, the prevention of hæmorrhage and the removal of all blood-clot, there is but little risk that the tied end of the pedicle will cause inflammation. It must be noted, however, that the ends of the ligature are now always cut short, and never, as in former times, brought out through the wound. It seems quite possible that another supposed improvement in practice which was believed to have greatly added to the safety of the operation may share the fate of the clamp treatment of the pedicle. It was thought for a time that the employment of the carbolic spray during the operation, and of the gauze-dressings afterwards, had very greatly helped the statistics of ovariectomy. Dr. Keith of Edinburgh had indeed attained the marvellous result of seventy successive recoveries under their employment. Recently, however, Dr. Keith and several other operators who had formerly used them have abandoned their employment and contented themselves with simpler forms of antiseptics. Opinions have even been expressed that the carbolic spray is in itself a source of some danger when applied to the peritonæum through a long operation; and recent facts, supported by the admissions of its warmest advocates, make it almost certain that its supposed advantages had been greatly overrated. In saying this I would by no means be held to imply that I think that the use of the Listerian precautions can be safely neglected by those who operate in general hospitals. If, then, we put aside the extra-peritoneal method with the pedicle and the carbolic spray during the operation, neither of them having maintained a permanent position as improvements, we may, I think, briefly mention the following as having been the most important in conducing to the results which we have witnessed. The first is the fact that ovariectomy has to a large extent fallen into the hands of specialists, whose skill and knowledge have become developed by constant practice. It may be doubted whether the statistics of ovariectomy at the present time, at general hospitals or in the hands of those who do the operation only occasionally, is much better than it was in the days of Walue, Frederick Bird, and Baker Brown. Secondly, surgeons have learned that it is best to do the operation deliberately, and that prolonged exposure of the peritonæum is not a matter of any consequence as compared with the risk which results from leaving either blood or cyst-fluid in the abdominal cavity. Thirdly, it has been made quite certain that the peritonæum does not resent the presence of ligatures cut short and left within its cavity. This applies not only to ligatures on the pedicle, but to those used to prevent hæmorrhage from torn adhesions, and we now most scrupulously tie every bleeding point and cut the ligatures short. Fourthly, we may cite, as minor matters which have been occasionally useful, the employment of glass drainage-tubes passed down into Douglas's pouch, and the use of the ice-cap in cases of unusual pyrexia. Undoubtedly the most important of what we have mentioned are the practices which are summed up in the expression 'Toilet of the peritonæum.'

Errors in diagnosis.—The principal mistakes which have occurred have been in respect—1st, to solid, or partially solid, uterine tumours; 2nd, to phantom tumours; 3rd, to pregnancy; 4th, to ascites; 5th, to hydatid cysts; and 6th, colloid disease of the peritonæum. One general remark may be ventured in reference to them all, and it is this, that the surgeon should place no trust in the patient's statements, but should, before undertaking any radical operation, carefully examine his patient by all practicable methods. A vaginal examination ought not to be omitted (unless the case is clear beyond a doubt), since in the very cases in which the surgeon

may feel more inclined to omit it (those, namely, of single women), it is most likely that a misleading history may have been given. Keeping in mind that ovarian tumours ought to be perfectly dull in front, and should leave a tympanitic space in one or in both lumbar regions, there will rarely be much difficulty as regards ascites or phantom tumours. Should any doubt be felt, changes of the patient's position, and re-examination by percussion, will generally clear it up in respect to the former; and the exhibition of chloroform in regard to the latter. In several cases of ovarian dropsy, complicated by existing but unrecognised pregnancy, ovariectomy has been performed, and in some with success. The differential diagnosis between uterine and ovarian tumours is by very far the most difficult of those under consideration, and under some circumstances may be impossible. The history of uterine hæmorrhage, the slower growth, the greater solidity,¹ more or less of fixation to the uterus are symptoms by which those of uterine origin may usually be known.

XI. OÖPHORECTOMY.

The operation of oöphorectomy (Battey's operation) has been repeatedly performed for the relief of troubles connected with menstruation, for neuralgic affections of the ovaries, and for certain aggravated forms of hysteria. Both organs are of course taken away, the pedicles are tied with Chinese silk and dropped back into the abdomen. In America removal through the vagina is frequently practised, and, provided the ovaries be not enlarged, it has advantages. The operation, although appearing to be very simple, is by no means devoid of danger. The mortality in completed cases has been at least twenty-two per cent. Its results in reference to the relief of nervous disturbance have been disappointing. In many cases there has been no improvement, and in some definite melancholia has followed. The operation has also been used in cases of long-standing prolapse of the ovary.²

XII. FISTULÆ COMMUNICATING WITH THE VAGINA OR UTERUS.

Fistulous openings may exist—1st, between the urethra and vagina; 2nd, between the bladder and vagina; 3rd, between the bladder and uterus; 4th, between the vagina and rectum. We shall omit here all consideration of openings caused by the extension of cancerous ulceration, since they are quite beyond surgical treatment. The various forms of simple fistulæ usually result either from contusions or lacerations in parturition, from the introduction of foreign bodies, or from the effects of calculous concretions in the bladder, or operations for their removal.

The inconvenience caused by any communication between the *bladder* and adjacent cavities is extreme. A large opening may, however, exist between the *rectum* and vagina without exposing the patient to much annoyance, since in many cases the involuntary escape of feces occurs only when the motions are unusually fluid. So great and so general has been the success obtained by operators in the cure of most of these forms of fistula, that it is scarcely worth while to occupy space by reference to less efficient modes of relief. Although by the use of the actual cautery small fistulæ may be much diminished, yet they can very rarely indeed be made wholly to close; and the after-treatment in these cases is just as irksome as in those of operation. On the other hand, the results obtained by Dr. Bozeman, Mr. Baker Brown, Mr. Bryant, Dr. Marion Sims, the late Sir James Simpson, and Mr. Spencer Wells, have been so exceedingly satisfactory that we may fairly rank the operative cure of these distressing conditions as a finished achievement.

Considering the want of success which attended the attempts of the earlier

¹ Uterine fibroids not unfrequently soften in the centre, and present the symptom of fluctuation more or less clearly marked. They often attain a size sufficient to distend the abdomen, as at the period of advanced pregnancy.

² See a report of an important discussion on this subject in the fourth volume of the *Congress Reports*, London, 1881.

surgeons, some of whom (especially Dieffenbach) devoted attention very perseveringly to the subject, it suggests itself as a most interesting question in practice, to what precise improvements have recent results been due? Speaking chiefly of vesical fistulæ, I think we may mention the following as amongst the chief: 1st, the use of chloroform, which enables the operator to proceed with much increased facility in the difficult steps of the dissection; 2nd, improved forms of suture; 3rd, the avoidance of the vesical mucous membrane, both in the dissection and in the application of the sutures.

The following are the steps of the operation in a case of vesico-vaginal fistula: The patient should be in her best state of health, and the bowels should have been well cleared out. Chloroform having been given, the woman is placed either on her side, with the knees well drawn up, or in the usual lithotomy position. The parts being well exposed by the duck-bill speculum, and the nates being held widely apart by an assistant, the operator proceeds to drag the opening as low down as possible, with a view to facilitate the paring of the edges. This may be accomplished either by hooks, blunt or sharp; by the use of a metal suture; or by the introduction of a flexible sound by the urethra, which is brought out again through the fistula, and then bent backwards. This latter plan furnishes the surgeon with a most efficient hook, and one which cannot easily slip. In paring the edges, it is necessary thoroughly to denude every part; for if the smallest portion of mucous membrane be left, it may prevent union. None of the mucous membrane of the bladder must be removed. The wound should present a bevelled oblique line, slanting from a large vaginal opening to a smaller vesical one. The denudation being complete and free, sutures are next to be introduced. These should be passed obliquely from at least a third of an inch outside the edge of the incision. They must not include the mucous membrane of the bladder. The tightening and tying of wire sutures is easily accomplished by the fingers. Care must be taken not to pull them too tight, so as to invert the edge of the vaginal mucous membrane. The instruments used in these procedures consist of small knives, forceps, and needles of various construction. Aveling's needle is in most cases the best; and the same operator has devised some wire coils which greatly facilitate the removal of the sutures. Provided the precautions insisted on, as to avoidance of the mucous membrane of the bladder, be observed, it does not appear that there is any great reason for preferring wire to silk.

It is now generally admitted, following Simon of Heidelberg, that it is not necessary to retain a catheter after the operation. The patient must lie on her side, with the knees drawn up, and every attention must be paid to sustaining her general health.

The sutures may be left in almost indefinitely; and unless it is clear that the operation has failed, they should certainly not be removed till the ninth or tenth day. If cicatrisation has occurred, they will cause no inconvenience; and their retention a few days longer than is absolutely necessary is a matter of no consequence, whilst their premature removal is a very grave error. It is needless to say that their removal should be effected with every precaution.

The nearer the fistula is to the urethra, the more easy is the operation in performance, but the greater is the chance that it may fail.

In cases in which the fistula is very high up—or, it may be, even connects the bladder with the cervix uteri—certain modifications in the plan of operation will be required. It may even become desirable to obliterate the upper part of the vagina, and to connect the uterus with the bladder, thus allowing the menstrual fluid to pass per vesicam, but preventing incontinence of urine.

The operation in cases of recto-vaginal fistula does not differ materially from that just described. The paring of the edges must be practised in a similar manner, and care must be taken to avoid the rectal mucous membrane. Whether or not the sphincter ani should be divided will depend upon the degree of tension which is present when the parts are brought together. It is not a slight measure, and should not be needlessly resorted to. In these, as in the preceding cases, the unencumbered suture of twisted wire, with Aveling's coils, is best. After the operation the vagina should be washed out by injections of tepid water daily.

XIII. CÆSARIAN SECTION.

It would be out of place here to consider any of the questions respecting the cases demanding this formidable operation, but it is desirable to describe its performance. The surgeon must provide himself with scalpels, directors, and forceps, and should have also a large probang armed with sponge. The patient should be placed on her back, with the shoulders and trunk a little elevated. The bladder should be emptied by means of the catheter. The incision through the abdominal wall must be made as in ovariectomy, and should extend from the navel to within two or three inches of the pubes. The uterus having been exposed, it should be held forwards by side pressure on the abdomen, and opened freely by an incision in the middle line. If it is intended to remove the uterus it may be best to bring it out of the abdomen before opening it. The fetus is then to be extracted before the uterus is detached. If the uterus is to be left the incision should not involve either the fundus or the cervix. An assistant should introduce a forefinger of each hand into the upper and lower angles respectively of the wound, and thus hook the organ forwards. After rupturing the membranes, the child is to be seized by the feet and extracted. The hand is next to be introduced between the membranes and the anterior wall, and the placenta is to be detached and removed. If the placenta have been found beneath the wound, it may have been necessary to detach it before removing the child. To restrain bleeding, the uterus should be compressed in the hand, or ice may be used, or, under urgent circumstances, the perchloride of iron may be applied. Before closing the wound, the surgeon should pass the sponge-probang downwards through the cervix into the vagina, to clear the passage. All bleeding having ceased, great care should be taken to remove any coagula from the uterine cavity, the wound, and the peritonæum. The decision as to the use of sutures to the uterus or not will depend upon the tendency to gape which may be observed. If there is much gaping, it will be better to put in a few interrupted sutures; but before doing this pains should be taken, by the use of ergot, &c., to make the uterus contract. Catgut must not be used, as it is not trustworthy. The wound in the abdominal wall must, lastly, be closed completely, as after ovariectomy.

The after-treatment will consist in careful attention to antiseptics and drainage, the efficient use of ice-bladders to the abdomen, and the internal administration of opium if required. Great care should be exercised in allowing the patient to take food if there is any tendency to sickness. Under such circumstances it will be far better to sustain her strength by enemata.

It is by no means impossible that in the future it may be found safer, in most cases requiring it, to remove the uterus as well as its contents, 'Porro's operation.' Since those who require the operation are usually the subjects of permanent deformity, nothing is gained by retaining this organ.

Dr. Eustache, of Lille, in drawing a parallel between this operation and embryotomy, estimates the mortality of the latter as fifty per cent., and on the whole thinks Cæsarion section the safer method when no third course is possible.

XIV. CLOSURE OF FISSURES IN THE CERVIX.

Autoplastic operations for the closure of fissures in the cervix uteri have of late years been frequently performed. They have been especially advocated by Drs. Emmet and Pallen of New York, on the alleged ground that these fissures, so common after parturition, are often the cause of nervous disturbance and long-continued uterine distress. Whether or not they do really stand in the relation of true cause to such consequences many authorities doubt. The operation is a simple one. The uterus is drawn down, the edges of the fissure pared, and sutures inserted.

JONATHAN HUTCHINSON.

DISEASES OF THE BREAST.

THE surgeon who desires to discriminate accurately between the different diseases of the breast, must never be unmindful of the physiological peculiarities of that organ, and the important function which it performs in the animal economy. Closely connected through the medium of the nervous system with the pelvic procreative organs, the breasts are intimately associated with them in the performance of their healthy functions, and are not less peculiarly sensitive to, and speedily influenced by, their morbid states.

Hence it is necessary to preface this essay with a few general remarks (1) on the anatomy of the gland at different periods of life, and under precise physiological conditions, for the brevity of which the required limitation as regards space must be pleaded as an excuse; (2) we shall refer to some of the more important points in relation to the diagnosis of the diseases; and (lastly) to their treatment.

Anatomy.—Unlike most organs of the body, this gland maintains a perfectly rudimentary state for several years after birth, until, like the others belonging to the function of procreation, its development advances synchronously with the ovaries and uterus, at a certain definite climacteric, termed the age of puberty. Even in both the sexes changes in this organ then take place. In the male, after slight temporary excitement, the action subsides, and a state of repose is maintained by it throughout the remainder of life, with rare exceptions. But in the female the rudimentary organ of the infant and of the child becomes developed into a gland at puberty, when a state of passive maturity only is attained. Still further changes are excited by the stimulus of conception, to convert it into the source of nourishment for the offspring; when, in this its most perfect state, it becomes an active organ, a secreting gland. Yet this is but a transient condition. For in the healthy state of the organ, it continues only as long as the stimulus to the activity of its function is applied; it immediately ceases when that is removed. It now resumes a state of repose, to be, nevertheless, excited to a repetition of its function as the stimulus arises. When, however, the demand for its functional activity is withheld, or the period of life is reached when the functions of the procreative organs become extinct, this gland also becomes wasted, and the process expressed by the term ‘involution’ takes place, or, in other words, atrophy occurs. It must be likewise remembered, that at every catamenial period more or less temporary sympathetic actions are excited in this organ.

In the human subject the normal number of the breasts is two. Deviations from this very rarely occur, but one or both may be absent (*amazia*); and cases of plurality, or excess of the usual number (*pleiomazia*), are recorded. The breasts are placed on the antero-lateral regions of the thorax, and occupy more or less superficial extent in different individuals. Hence they are termed pectoral. They are interposed between the integument with the subcutaneous fat and the great pectoral muscles, beneath the inferior and axillary border of which a portion of the glandular tissue often extends. They are held in their position by fibrous bands, which extend from the integuments to the fascia of the pectoral muscle, between the separate masses of glandular tissue; these are the suspensory ligaments of Sir A. Cooper.

Examples are recorded in which glands secreting milk, supplementary to the normal breasts, have existed on the thorax, in the axilla, on the back, the abdomen, and in the groin. The shape of the breast varies considerably at different ages, under its changeable functional states, and in different individuals, in relation to

their peculiarities of nutrition. Considered as a single gland, the shape of the whole is hemispherical, the convex surface being in immediate relation with the integuments. The whole organ is constituted of a variable number of individual lobes, each one having its separate excretory duct or lactiferous tube. These are again divisible into lobules, in which are observed the acini, composed of the cæcal terminations of the ducts. The lactiferous tubes commence in these cæci, and the minute ducts unite and unite until a single canal is formed, which, after dilating before it reaches the nipple (the reservoir of Sir A. Cooper, or sinus lacteus), terminates in an open mouth thereupon. Every acinus, lobule, and separate lobe possesses a delicate fibrous envelope, and all are united together by means of the ordinary connective tissue which abounds in this organ. That segment of the breast nearest to the axillary and abdominal regions of the body is the largest. The fossa or sinus between the breasts is called the bosom. The *nipple* is that division of the gland to which all the ducts converge, which projects upon its surface, and is surrounded by a dark circle of skin called the *areola*. It is composed of a large quantity of contractile fibre-tissue, as well as connective, through which the milk-tubes pass to terminate in open mouths upon its apex, between the superficial rugæ of its cutis. Beneath the skin of the areola numerous sebaceous glands are usually distinctly visible, but not constantly.

The mammary organ undergoes great changes at different periods of life. In infancy, it is but rudimentary, and although it enlarges and even secretes milk a few days after birth, it is not until the age of puberty that the glandular tissue is really developed in any quantity. At this time remarkable structural changes occur, and in a few months the growth of the organ is complete. But even then it is only perfect to a certain point. After puberty we therefore recognise two conditions: a state of inactivity or repose, passive maturity; and a condition in which the function of the gland is actively performed, when milk is secreted. At a subsequent period the tissue of the gland generally becomes atrophied, and fat occupies the place of the gland-tissue. The ducts, however, are persistent. Associated with these different states there are certain diseases requiring to be specially noticed. It therefore behoves the surgeon to take cognisance of them in all cases of disease, the nature of which he may be required to discover.

Whilst investigating the development and structure of the breast, it is essential to bear in mind the two parts into which every secreting gland is divisible; that is to say, those structures within which the secretion is formed, and the tubes along which it flows away: or, in other words, the secreting portion of the organ, and the excretory ducts. The progressive development of this gland takes place very slowly, and is intimately associated with certain definite periods in the life of the female. We shall therefore describe its condition at birth and before puberty; at puberty and subsequent to that period; after uterine conception, after parturition, and during lactation.¹

1. *Anatomy and diseases of the rudimentary organ at birth and before puberty.*—Before birth, soon afterwards, and to the age of pubescence, the glandular element consists of the excretory ducts only, in a more or less rudimentary state, imbedded in a fibrous stroma. In their earliest condition they are not even tubular, but solid, and are composed of an aggregation of nucleated cells terminating in clavate ends. Each duct radiates from the nipple towards the periphery, by gemmation becomes more and more branched, and, by slow degrees, a tube. Before birth the nipple is represented by a slight depression. Here we may observe that in many of the *adenoid*

¹ The reader, desirous to peruse a more detailed and minute description of the physiological anatomy of the breast-gland than the writer is permitted to introduce into this essay on its diseases, may refer to *The Anatomy of the Breast*, by Sir Astley Cooper, 1840; *Ueber d. Bau u. d. Entwicklung d. Milchdrüse bei beiden Geschlechtern*, von Dr. Carl Langer, Wien, 1851; *Mikroskopische Anat., oder Gewebelehre d. Menschen*, von Dr. A. Kölliker, b. ii. p. 467, 1854; or the translation of Kölliker's *Manual of Histology*, published by the Sydenham Society, vol. ii. p. 272. Also an article entitled 'Pathologische Anat. d. Brustdrüse', von Dr. H. Meckel, in the *Illustrirte Med. Zeitung*, von G. Rübner, b. i. 1852, p. 141. Stricker, *Handb. d. Lehre v. d. Geweben*, Leipzig, 1870.

growths, to be hereafter described, structures resembling those above mentioned are seen, and they are probably identical. Also that this rudimentary state of the nipple sometimes remains persistent throughout life. Soon after birth, in both sexes, the rudimentary organ becomes swollen and tender, at which time a little secretion sometimes escapes from the nipple, which, of course, is extremely minute. A well-marked hardness may be felt, which, when pressed, causes pain. By the officious interference of nurses, this excited organ is often inflamed when they use rough and frequent frictions to 'rub away the milk.' If this rudimentary organ be examined after death at this moment, it shows remarkable vascular congestion.¹

2. *At puberty*, and especially after the appearance of the catamenia, the secreting portion of the organ becomes developed. This consists of the cæci or true terminal gland-vesicles, which are first perfected at the borders of the gland only, causing when touched a sensation as of minute granules subcutaneously seated. These terminal vesicles are formed of a structureless membrane. They are connected with the terminal branches of the ducts, and are externally covered by a network of capillaries. Their contents are oval and flattened nucleated cells. The breast having reached a state of passive maturity does not appear to be divided into individual masses, and the surface of its section is therefore perfectly smooth, homogeneous, and of an opaque yellowish-white tint. But a gland by which milk has been once secreted shows the separate masses of which it is composed much more distinctly, as the connective tissue unites them together less firmly. The ducts in the peripheral portions of the gland are always in a more advanced state of development than those in the centre, in the virgin as well as in the puerpera. The stroma of the breast consists of fibre-tissue in large proportions. It is chiefly filamentous and wavy; but intermixed with it is that variety so abundantly met with in the contractile membranes. Doubtless this tissue preserves the form of the organ, as well as assists in compression of the milk-tubes. Besides these tissues we see a well-defined fascia or membrane investing the most minute divisions of the gland-structure, its lobules and lobes. A double outline is thus produced bounding the cæci.

In the adenoid growths developed in the breasts of girls and young maidens, we meet with structures identical with those above described. Many of those tumours are, indeed, absolutely extra growths of the tissues composing the breast, and in some instances of even single and married women, the new growth attains to the perfection of the normal gland and secretes milk.²

At puberty the development of the breast advances rapidly in healthy girls. In males it is often attended with pain, which lasts but a few days, and then subsides. Occasionally, however, the region becomes much swelled, the integuments around the areola pink or red, with a conical prominence of the nipple and enlargement of the areolar sebaceous glands. When this excited action has somewhat subsided, a little serous discharge sometimes oozes from the ducts on the nipple. Usually youths take little notice of these changes; but now and then, either from alarm at the occurrence, or from pain attending the pressure of the dress or manipulation of the part, the advice of the surgeon is asked. The age of the patient in whom the complaint occurs is the best aid in diagnosis. The removal of every cause of irritation, the application of moisture, if the part be red, enjoining repose, and attention to the general health, suffice to remedy the trouble. Should abscess occur, it must be treated *secundum artem*. Permanent enlargement of this gland is sometimes met with in delicate men, either on one or both sides. It is termed *gynæcomazia*.

In the female the progressive development of the gland generally advances in both breasts simultaneously, unassociated with local or constitutional disturbance. On the other hand, some girls show the anomaly of unsymmetrical development—that is, one breast enlarges and reaches a considerable size before the other makes any

¹ On the secretion of milk in new-born infants, see an interesting paper by Natalis Guillot read before the Academy of Sciences in Paris, in October 1853; or a translation in *Edin. Monthly Journ. of Med. Science*, February 1854.

² See cases in *Guy's Hospital Reports*, 1855, Adenocoele, case 1, with a lithograph, and case 2. Since the publication of those cases, the writer has met with others.

advance towards development. The age at which this strange defect takes place, concomitant with other phenomena of girlhood life, should guide the surgeon to a correct diagnostication of its nature. After reassuring the patient and her friends, the rest may be left to nature. Usually the commencement of mammary development precedes the first catamenial period; and if the breasts should sympathise with any morbid state of the ovarian functions, suitable medical treatment is indicated. It is a matter of considerable importance that, in order to favour the healthy development of the breast, the pressure of the dress against the growing organ should be studiously avoided.

The nipple and areola.—The nipple is composed of the ducts united together by connective tissue, with blood-vessels, lymphatics, and nerves. These are all covered by skin, upon the surface of which, and beneath the cuticle, lies a layer of pigment cells. To this the colour of the organ, as well as that of the areola, is due. The shade of brown varies from a light to a darker hue, according to the complexion of the individual and the active or passive state of the gland itself. The connective tissue contains also contractile fibres, unstriped muscle, which, when excited to contract by any local irritation, or even mental emotion, produces a rigidity of the whole organ, which has been termed erection. There is not, however, a trace of true erectile tissue to be seen in it; the capillary blood-vessels are numerous and looped, and they may become congested; the milk-tubes may likewise be turgid and distended, as occurs during lactation; but the prominence and rigidity of the nipple, occurring in the virgin or married woman, is really only attributable to the existence of the contractile tissue, a layer of which exists also beneath the cutis of the nipple and areola, and produces the peculiar corrugation of that dark circle of integument. If looked for, it will be seen that the *cutis anserina* of the surrounding integument usually accompanies the condition of the nipple above alluded to. Covered by the skin of the areola are the lacteal sinuses. Here the ducts dilate before entering the nipple. Within that organ they are again contracted, and where they traverse the cutis each tube is extremely fine. Their open mouths are protected between the rugæ of the cutis; for the terminal boundary of the nipple is somewhat flattened and rugous. In these furrows small ulcers are frequently formed, and the secretions of the minute follicular glands and of the ducts, when allowed to accumulate, cause considerable irritation and inconvenience. The contractile fibres in the apex of the nipple may subserve the important purpose of preventing the constant flow and escape of the milk from the ducts. The validity of this statement can be tested by examining the nipple when its ducts are distended and the outlines visible near its root or beneath the areola. But as soon as the warmth of the infant's mouth induces a relaxed state of these fibres, the mouths of the ducts are no longer compressed, and the milk flows freely.

The glands of the areola.—Within the area of the areola are situated hair follicles and sebaceous glands; the latter are often arranged with considerable regularity, especially a circle of them, smaller than the others, near its periphery. The large sebaceous glands elevate the delicate cutis of the areola, beneath which there is always an absence of fat. Hence sebaceous tumours are occasionally developed in this region. Hairs are rarely developed, except as age advances, or as correlative with a somewhat masculine development, or tendency to hairiness generally.

The nipple also becomes somewhat further developed at puberty in the female. It forms with the areola a conical elevation of the skin, having a bluish or pinkish tint; but it does not project much until a later period of life, often never at all in unmarried women. The size of this organ varies exceedingly in prolific women as well as in sterile; for, even in those who have suckled large families, its size often bears no proportion to the use made of it. In shape, too, it is very variable. Sometimes it is bifid at the extremity, and even two nipples have been seen on one breast. Anomalies in number and position occur in both sexes. But the most serious deformities affecting this organ are those where the development of its projection is arrested and it continues flat; or when, worse still, a depression or hollow only exists, in which

the milk-tubes terminate. Very rarely, a duct opens on the areola, not as the result of disease, but as a congenital imperfection.

Cases of precocious development of the breasts are recorded.¹

3. *After the complete establishment of puberty; after uterine conception; after parturition, and during lactation.*—The only normal changes in the female breast which occur irrespective of conception are slight enlargement, attended with more or less pain, according to the susceptibilities of individuals, at each catamenial period, and a slight change in form and consistence soon after congression with the other sex. The nipple, areola, and its glands show great changes, as respects form and colour, under these circumstances, as well as after much handling and uterine conception; but it would be foreign to our purpose to enlarge upon them.

The changes of most importance affecting this organ are excited by conception. Now it is that its peculiar function to secrete food for the nourishment of the offspring is about to be performed; and from month to month, simultaneously with the development of the fœtus, alterations in the condition of the breast are observable. These changes are most easily watched in women having small glands; for in such the secreting portion of the organ would seem to disappear almost entirely after the cessation of lactation; whilst in those whose breasts remain permanently large throughout life the structural changes are not so easily detected. Nor does the size of the organ bear any just proportion to the perfect performance of its function; for, as a rule, large breasts do not secrete so freely as small ones; and generally, when the milk is abundant, it is very poor in its nutritious qualities. Neither are its dimensions always in relation to the constitutional nutrition of the woman. For we often see strumous, cachectic girls with largely developed mammae, whilst healthy, well-nourished maidens offer the opposite condition. It is probable that sexual impulse determines, to a certain extent, the growth of these organs. And further, it should be recollected that bulkiness is not always due to excess of gland-tissue, but to a growth of fat.

Where the gland-tissue has arrived at *the stage of passive maturity*, after puberty, the secreting portion of the organ can be very clearly seen, in consequence of the caecal terminations of the ducts containing more or less epithelium. In addition to the gland-tissue, there is usually some fat diffused throughout the stroma in small lobules. The adipose tissue is more abundantly developed around the borders of the whole gland and upon its anterior surface; but it is rarely found between it and the pectoral muscle. As years pass on, however, when the breast has never been excited to the performance of its peculiar function, the caecal terminations of the ducts are with difficulty detected, and the entire mass of the organ seems to be composed of fibre-tissue, fat, and ducts only. But at any moment the stimulus of excitement, reflected from the pelvic generative organs, may give rise to a certain amount of activity in the caecal ends of the ducts, which become congested with epithelium, and thereby is produced more or less general enlargement and induration of the whole breast. When, as commonly happens, the stimulus excites a single mass or a lobe, or even separate lobules, the swelling and irregularity to the touch produced thereby causes misapprehension that a new growth is developed. Such, however, is not a fact. We have to deal in such cases with a morbid state of the true gland-tissue, not with something superadded to the normal organ—a distinction not without a difference, for it is based upon structural peculiarities, and is of paramount importance as regards the treatment of the case.

After uterine conception the breast becomes at first full and firm, when small granular bodies may be felt around its periphery and upon its cutaneous surface. If a section of it be made in about the third or fourth month of pregnancy, the tint of its tissues is pale red and the surface irregular, especially at the periphery; it is no longer a uniform white, opaque, homogeneous mass; although in its centre the changes are only just perceptible in comparison with those at the periphery. The vascularity of the organ is also one of its marked features, for minute blood-vessels

¹ *Lond. Journ. Med.* vol. i. p. 85; *Gaz. méd. de Paris*, 1834, p. 881.

are visible ramifying in its tissues. In the passive organ scarcely a vessel is noticeable. If one of the minute granular bodies (a gland acinus) be removed, and its tissues carefully separated with needles, the caecal terminations of the ducts are distinctly seen by the aid of a microscope. The addition of a drop of dilute acetic acid favours the observation of this object. The limiting membrane, or tunica propria, of the terminal gland-vesicles or caeci encloses more or less epithelium, the separate elements of which are oval and nucleated. In the centre of the breast the stroma shows a curious reticulated structure, in the meshes of which the writer is inclined to believe the acini are subsequently developed. At a later period of uterine conception the caeci are in greater abundance, and contain colostrum-corpuscles in addition to the epithelium.

After parturition and during lactation the surface of a section of the breast is deeply divided into lobes and lobules, and the acini are very distinct. It closely resembles the cut surface of a parotid gland or a pancreas. The caeci are filled with epithelium, which also contain the cells bearing the fatty globules found in milk. The breast has now attained its state of active perfection.

Such is a brief description of the metamorphosis of the inactive organ into an active secreting gland. In the perfection or imperfection of the changes taking place in the secreting portion of the glandular tissue we may seek an explanation of those cases, rare though they be, in which no sympathy seems to exist between the breast and the gravid uterus, and of others in which milk is never formed. In the first defect, when there is not any change during pregnancy, the caecal terminations of the ducts are not developed, therefore the cells cannot be generated in which the fatty particles of milk are formed; and in the second, although the gland-vesicles may be complete, yet the epithelium is not perfected, and the milk-globules are absent.

Innervation.—The following scheme demonstrates the distribution of the spinal nerve-filaments to the skin over the breast, to the gland itself, and their associations with the cutaneous filaments of the contiguous regions. The breast also has filaments from the sympathetic system.

Cervical plexus.					
Posterior filaments of 4, 5, 6 unite with posterior branches of superior dorsal.			Anterior branches of 4, 5, 6 (?) supply skin over breast and unite with		
Dorsal plexus	Middle intercostal nerves	2. Also, skin inside of arm and axilla.	Breast and skin over it.	2.	Anterior intercostal nerves
		3. Also, skin of acromion, axilla, and arm.		3.	
		4. Also, skin over scapula.		4.	
		5. Same.		5.	

It should be thus read. The breast and the skin covering it are supplied by filaments from the anterior branches of the fourth and fifth cervical nerves. Filaments from the posterior branches of the same nerves join with others from the superior dorsal nerves. Filaments from the middle and anterior intercostal branches of the anterior division of the second, third, fourth, and fifth nerves of the dorsal plexus supply the breast and skin over it chiefly. A minute examination demonstrates the association between the second intercostal and filaments supplying the skin of the inside of the arm and axilla; also the same parts and the skin about the shoulder from the third; and the skin about the scapula from the fourth and fifth. These

nervous intercommunications explain the widely extended pain of which patients so grievously complain when affected with mammary hyperæsthesia.

The arteries and veins.—The second, third, fourth, and fifth intercostal branches of the internal mammary artery usually convey blood to the sternal segment of the breast; within the axillary portion a large branch from the artery of that name very commonly ramifies; and the inferior and lateral regions receive a few branches from the intercostal vessels, which pass with the nerves through the middle intercostal foramina. As the nerve filaments accompany the arteries, it is necessary to be careful to avoid embracing them in ligatures if used to arrest bleeding. This precaution is now no longer called for, as the writer has found that torsion of the arteries suffices to arrest hæmorrhage.

The veins usually accompany the arteries, and terminate in the internal mammary and axillary trunks. A peculiar arrangement of the subcutaneous veins around the areola has received the name of *circulus venosus areolæ* (Halleri). The superficial veins are often dilated in those cases in which tumours are developed in the breast. This morbid condition seems to arise partly from their pressure, the interruption to the flow of blood, and probably to the increased quantity circulating through the growth.

The superficial lymphatic vessels terminate in the axillary, the cervical, and anterior mediastinal glands; a deeper series pass over and beneath the pectoralis major muscle to the glands placed under the clavicle.

General observations relating to the diagnostication of the diseases of the breast.—

The diagnostication of the diseases of the breast is considerably assisted by ascertaining the age of the patient at the time of the development of the growth and its relation to the state of passive maturity or functional activity of the gland. The surgeon should ascertain the social position of the patient and her temperament; observe the condition of her nutrition, and especially whether, in relation to her actual age, she shows a youthful or aged aspect. The functional powers and derangements of the pelvic generative organs must be ascertained with precision, and in relation with them the state of the breast should be compared, as well as that of one breast with the other. Discharges from the nipple, its ordinary development, and any deviations from a normal condition, are important subjects, and should elicit inquiries relating to congenital or acquired defects. Uneasiness; temporary, transient, or persistent pain should be traced in certain defined directions with anatomical precision; and the intimate association between the nerves of the gland and the neighbouring plexuses cannot be too carefully remembered. The lymphatic vessels and the glands in the axilla should never be overlooked; and even a wider range of observation, comprehending those above the clavicle and in the anterior mediastinum, must be taken. Having carefully obtained a knowledge of the facts above alluded to, the surgeon has then to determine whether the disease under observation involves the normal tissues composing the organ, or whether there be a new growth.

The age of the patient should be carefully ascertained, with the view to discover the period of life at which the disease was first observed; *e.g.* by deducting the age of a new growth from the actual age of the patient at the moment of observation. That inquiry enables the surgeon to determine whether the existing affection is associated with the development of the gland, its state of maturity, or a condition of repose and atrophy. Also, the actual age being known, the surgeon is enabled to decide whether the patient shows signs of premature age, a fact often of great moment in deciding on cases of carcinoma.

The social relations of the patient, whether living a life of excitement, celibacy, or the contrary; if married, whether prolific or sterile; and if prolific, whether the uterus has performed its functions in a healthy manner or not, are facts to be noted, several of its morbid states being closely connected with the secondary influence of social conditions, as the indurations of the gland-tissue in unmarried women, or in others who, although married, are yet sterile. Again, the activity of this organ, sympathising as it does with the functional changes occurring in the uterus, is excited

to increase of growth in preparation for the performance of its functions; and such normal increase in bulk might be mistaken for a morbid process, unless the actual social relations of the individual be conclusively established. Nor should the habits, occupation, and possible moral depravity of the sufferer be wholly neglected; for indulgence in vicious propensities doubtless exerts a secondary influence on the mammary organ: such as illicit intercourse with the male sex, intemperance, indulgence in spirituous liquors, unnatural sexual excitement, the use of means to procure abortion, and constitutional syphilis. A strange perversion of the moral feelings occasionally exists which incites to the production of factitious disease in this part.

Observing the temperament of the patient sometimes assists in distinguishing the nature of the morbid affection: *e.g.* in girls of an excitable nervous disposition, the gland is frequently exquisitely sensitive without being absolutely diseased, and some even describe an intensity of suffering and misery wholly incompatible with tangible local symptoms. A state of hyperæsthesia exists, purely, free from organic morbid processes.

The healthy nutrition and youthful aspect of one sufferer, as well as the cachectic care-worn look of another, both perhaps of the same age, are useful facts to aid diagnosis, although they must not be allowed paramount influence in every case. Thus, in a girlish, healthy-looking woman, a growth in the breast, however large, may be pronounced innocent, almost with certainty; whilst in another the anxious mien and aged facial aspect, the result of constitutional dyscrasia, may excite the suspicion of carcinoma. Caution must always be exercised in those instances in which the local disease, although physiologically innocuous to the constitution, may have excited much mental distress and bodily suffering in consequence of its condition during progressive stages of growth.

An inquiry into the state of the functional products of the generative organs should never be neglected, especially as regards the catamenia. The opposite conditions of excess and deficiency of the menstrual flux incite to sympathetic processes in the breast, and a certain class of its diseases are probably dependent entirely thereon.

When any disease occurs in the breast of a child-bearing woman, the capability of its functional powers should be ascertained; and if from any decided cause its secretion happens to have been interrupted or arrested, an attempt should be made to associate the existing disease with the active state of the gland. It frequently happens in such cases, whether associated with deformed nipple or not, that disease appears even many months after lactation has ceased, generally assuming the form of chronic abscess. This affection, however, is most common when the nipple has not been perfectly developed. In an imperfect state of the nipple, we have a fruitful source of trouble, and the natural conformation of the body of the organ, as well as of the nipple, prior to the discovery of any disease, should be carefully ascertained in every case specially under observation.

A knowledge of the manner in which lactation may have been performed by the two glands comparatively; the number of times that function has been excited and its duration, together with the diseases occurring during those periods, often aids the diagnostication of a disease existing a considerable period of time after the cessation of suckling, and which may be even intimately connected with some irregularity occurring at that time.

Without putting a leading question, the surgeon should ask the patient to describe the sensation or pain felt in the part; but he must be somewhat on his guard against implicitly accepting her statement. If the sufferer has read upon the subject of cancer, and believes herself to be affected therewith, she will certainly state that the pain is 'lancinating, darting, stabbing,' and so on; and again, the intensity of the pain is sometimes exaggerated. But there is pain which happens to be so characteristic of the class of diseases it accompanies, that its nature and the method of inducing it becomes pathognomonic of the special affection. The anatomist will remember that the integuments over the mamma, as well as the

organ itself, receive their nervous filaments from the second, third, fourth, and fifth nerves of the dorsal plexus; that those branches called intercostal divide into middle and anterior cutaneous filaments, which are the nerves of this gland, and that they reach the skin by passing through openings between the ribs. The widespread distribution of other filaments of these same dorsal nerves should also attract attention (see p. 426). Now when a patient complains of inordinate pain in the breast, with or without induration of the tissues, the acute sensitiveness of the nerves distributed to it is easily demonstrated by digital pressure over the middle or anterior intercostal foramina, whence they emerge upon the chest. In severe cases of this neuralgic affection gentle pressure is intolerable, and the pain extends far and wide over the back, neck, and arm. Even the nerve supplying the particular lobe which is indurated is sometimes alone affected, whilst in actual new growths this is not commonly the case. Thus local pain and pain widely distributed, as well as pain excited by the application of digital pressure with anatomical precision, becomes an important aid in the diagnosis of some of those affections of the breast which excite the greatest alarm in the mind of the patient, although happily they prove to be harmless, in spite of the difficulty sometimes experienced in affording speedy relief.

In every case immediately under observation the surgeon should first attempt to ascertain definitely whether the disease affects the normal tissues of the organ, or whether there be something superadded to them; in fact, a new formation or growth. A tumour, swelling, or enlargement may be felt, and still there may not be any growth in addition to the normal structure; *e.g.* a single lobe of an inactive gland may be enlarged and cause a suspicion that a new growth exists; but if it be cut out and examined, only gland-tissue is found gorged with epithelium. By careful and methodical manipulation, however, this morbid lobe of gland-tissue, a very common affection too, may be certainly distinguished from a new growth. In this manner examine the part: Press the induration gently between the thumb and fingers, and a tumour is so distinctly felt that the positive existence of something superadded to the breast is affirmed; but now place the fingers lightly and flatly upon the part over the site of the supposed new growth, pressing gently against the thorax, and nothing more than the ordinary gland-tissue is perceptible. On the contrary, if there be a genuine new growth, something developed recently within the normal gland, it will be always felt, in whatever manner or in whatever position the patient is examined.

Condition of the nipple and of discharges therefrom.—The ordinary condition of the nipple preceding the observation of the disease should be always ascertained with precision. A congenital defect in its development commonly causes great trouble during suckling, is the promoter of some disease associated with that function; and often accompanies some new growths. It may, however, become retracted when chronic inflammation, or even acute and lactic congestion, affects the organ; and therefore this state cannot be considered of real value in aiding the diagnostication of any special disease. Even when accompanying carcinoma, it merely marks a stage or particular condition of one kind of that disease. The fluids which sometimes ooze from the nipple at the commencement or during the progress of a new growth, may be rendered subservient to the formation of a correct diagnostication of the nature of the disease in the part. Sanious, offensive, opaque discharges, containing cells, identical with those forming growths of cancer, may be regarded as indicative that the induration which would probably accompany the exudation of such fluid arises from infiltrating carcinoma; whilst a bright yellow clear tenacious serous fluid, drawing out into thread-like processes, and the flow of which is perhaps increased by compression on a circumscribed collection of fluid, would guide the surgeon to an accurate opinion that the tumour depended upon the presence of an adenoid growth, or a simple cyst. In a similar manner some of the duct-cysts may be diagnosticated from the mucoid character of the fluid escaping from the nipple. Serous fluid containing colostrum particles may accompany an excited state of the gland-tissue, sympathetic with diseased ovaria.

The lymphatic glands in the axilla and in the neck just above the clavicle should be always carefully examined. Some care is here requisite to ascertain if their morbid condition, when any may happen to exist, preceded or followed the disease in the breast.

In order to insure perfect accuracy in diagnosis, especially of obscure cases, the breast should be examined whilst the patient is seated, and also when placed in a recumbent posture. The affected gland may then be carefully supported upon the trunk by slightly rolling the body over on to the opposite side and placing a pillow under the shoulder.

Briefly, then, the surgeon will be led to these inquiries: Has the disease under examination any manifest connection with the age of the patient; the stage of development of the gland; its functional activity or repose; and the social condition of the patient? Does it seem to be associated with any general disturbance of the functions of the generative organs? Is it merely a local affection, or more intimately accompanied with general constitutional dyscrasia? Is it of inflammatory origin? Is it traceable to a morbid state of the excretory ducts, or of the secreting structure of the organ? Is the tumour composed of a fluid, a solid, or of both? And, lastly, is the swelling, tumour, or tumefaction really caused by something growing in the breast—a new growth; infiltrating the tissues of the breast; inflammatory or otherwise; or simply a morbid condition of a part or whole of the actual tissue of the organ—an excited state of the gland-structure? In other words, is the disease *in* the breast, or is it a morbid state *of* the tissues composing the breast?

The formation of a correct diagnosis between one disease of the breast and another is infinitely facilitated by employing the method of exclusion or negation; e.g. suppose the patient under observation to be afflicted with a certain definite disease, and then endeavour to ascertain if the facts of the case agree with those indicative of that class. If they do not, that assumption is set aside, and another adopted and examined in a similar manner. This method, however, requires considerable experience, and is not therefore, perhaps, available for very young practitioners. Surely, there is much force in the maxim of Dupuytren, when applied to tumours in this region: ‘Nothing is more difficult or uncertain than the diagnosis of tumours in general.’

General therapy.—First, in relation to the healthful development of the gland from birth to puberty; during pregnancy; and after parturition.

Soon after birth, when the integuments around the mamilla are swollen and tender, great care and attention are required on the part of the nurse, that the dress of the infant does not compress the chest, and thus irritate and injure the rudimentary organ. Should the skin around the areola become red and painful, a thin layer of cotton-wool moistened in water and laid on the part, is the most suitable protection. The treatment of the diseased states is described in another place. All manipulation of the swelling is reprehensible in the highest degree.

At puberty the gland should have free scope to allow for enlargement, and pressure on the nipple ought to be carefully avoided. The ordinary tenderness experienced by delicate and excitable girls at this time, and especially at the catamenial periods, requires only repose and the withdrawal of all causes of local irritation.

During pregnancy arrangements should be made in the dress to prevent the clothes compressing the gland, or irritating and squeezing the nipple. If that essential portion of the organ be imperfectly developed, or even inverted, as sometimes happens, and a depression instead of a projection exists, measures may be taken with a view to encourage its development. These would consist in fixing over the areola a circular piece of some thick, unirritating material with a hole in its centre. We believe that very slight advantage is gained by the application of medicated lotions to the nipple as prophylactics against the irritation caused by suckling. As soon, however, as the colostrum is secreted and oozes from the ducts, the extremity of the nipple should be carefully cleansed with warm water, lest, in drying, the mouths of the ducts should become irritated, perhaps obstructed.

After parturition the infant may be allowed to suck as soon as possible, that is, as regards the breast. Its functional activity is not, however, perfect until after the lapse of a few hours from that event. But great distension should never be permitted to occur; and when the secretion forms in such large quantity that the efforts of the infant are unequal to the prevention of this condition, some artificial means should be adopted to avert the ill results consequent upon the neglect of that state. During the earlier periods of suckling the nipple should be gently bathed with warm water when the infant desists; some protection against the friction of the dress is desirable, especially when there is a tendency to irritable nipples; and all nostrums, applied under the impression of 'hardening the nipple,' scrupulously rejected. Much vigilance is advantageously employed in seeking for 'milk-knots' or 'coring of the milk,' as these hard lumps are commonly called. This morbid condition, being due to lobular congestion, will, unless relieved, inevitably proceed to inflammation and abscess. Gentle frictions, with olive-oil, sometimes help to disperse such swellings; but they should not be employed unless by the direction of the surgeon. To the application of warmth and moisture we give the preference; and a careful examination of the orifices of the ducts should be instituted, in search of obstructions from accumulated secretion or epithelium. As the comfort, happiness, and well-being of the mother and infant are so inseparably blended with the healthy performance of the function of lactation, it is impossible to devote too much attention to the search after the least trace of morbid action.

At the time of weaning the breast should never be allowed to become excessively congested with milk. A very small quantity should be removed by artificial means, only just sufficient to relieve distension, never to excite a renewal of secretion. Repose must be enjoined, and an active use of the upper extremities restrained for a day or two. If any circumstance has necessitated the relinquishment of suckling for a brief period, a healthy secretion may be sometimes regained, even after the lapse of a few weeks, by letting the infant suck if it will, or by making use of a breast-pump.

Secondly, in relation to the therapeutics of diseases.

The following remarks refer chiefly to methods of treatment applicable to many different kinds of diseases. The special treatment of any one particular disease is described in that part of the essay devoted to its consideration.

Support and compression.—The principle embodied in every method which has for its object the support or suspension of the gland against the chest, is, in fact, that of repose. By the methodical adjustment of a bandage to the breast, its movements are restrained, and the tissues which are progressively advancing towards a resumption of a healthy state are not liable to those injurious effects which the weight of the gland might exert on delicate, newly formed structures. A suspensory bandage may be employed. It should be made of some soft fabric with rather open texture, in order to avoid excessive heat. It may be so shaped as to fit the organ, and retained in its position by two broad bands of calico, one passed over the opposite shoulder, the other encircling the trunk below the breasts. An ordinary bandage or roller made of calico, soft linen, muslin, or the elastic woven fabric, about one inch and a-half to two inches wide, may be adjusted in the following manner. The surgeon, standing before or behind the patient, who should be sitting, passes an end over the opposite shoulder as low down the back as the lumbar region. The bandage is then carried round the trunk, and the next turn taken over the shoulder, beneath or across the breast, and again around the trunk and then over the shoulder, and so on, alternately, until the part is entirely enveloped. In this way, one fold overlying that below it, a very firm, uniform, and tolerable support is afforded. At certain points, where the folds of the roller cross, a few stitches may be inserted with advantage. In some cases, strips of lint smeared with an ointment may be laid on the breast, and kept in that position by means of plaster. There are two ways of applying plaster—in a single circular piece, or in strips. If in one piece, a hole should be cut near its centre for the nipple to go through. Incisions should be made from the margins of the circle converging towards the centre, and terminating near the hole.

When applied, the pieces slightly overlap each other, and lie flatly. Another plan consists in cutting a piece of adhesive plaster in the shape of a crescent, and fixing it to the abdominal half of the gland. A piece about two inches wide is afterwards placed on the sternal and axillary borders, somewhat obliquely, and extending towards the centre of the clavicle. A third consists in applying strips of plaster one inch and a-half in breadth, one piece slightly overlying the one below it. The operator begins at the abdominal border of the gland, and covers as much of it as is needful. During all these operations with strapping, the patient should be in the recumbent posture, and the trunk slightly inclined to the opposite side, in order that the breast may rest upon the chest and not be pendent. Various substances have been used to fix the bandage securely, viz. adhesive plaster outside of it—this may be useful if the skin be irritable; starch, gum, collodion, dextrine, and even plaster of Paris; but all of these make the bandage very rigid, therefore often intolerable, and, when a necessity exists for its repeated application, inadmissible. Should the nipple become ulcerated and require protection, shields are made of various materials; of metal, as lead; of vulcanite; or of something softer, as vulcanised india-rubber.

Sinuses may be injected through the fistulous openings in the skin with various stimulating injections. To do this effectually it is well to make use of a piece of flexible catheter, which should be introduced as deeply as possible to insure the full effect of the injection. As a drain-tube, a contrivance, well suited to effect the purpose intended, consists of a piece of very thin gutta-percha, rolled up in the form of a tube, inserted to the requisite depth.

The milk may be artificially removed from the breast by means of exhausting syringes, made for that purpose; by glass tubes or bottles to which some arrangement is affixed in order that exhaustion may be effected by the mouth; or a wide-mouthed bottle may be used, which, after being filled with hot water and emptied, is applied over the nipple. As the air within cools, the mouth of the bottle must be very carefully kept in contact with the breast.

Amputation of the breast.—The proceedings adopted in the removal of tumours from the breast are described in their proper places. The entire gland may be excised in this manner: An elliptical incision is made upon either side of the nipple, the distance from which may be left to the discretion of the operator. Flaps of integument should be made of sufficient dimensions to fall together readily, without stretching them. The direction of these incisions should correspond with that of the fibres of the pectoralis major muscle. The lower or axillary flap should be made first, and the surgeon will find the accomplishment of the operation facilitated by detaching the gland from the fascia of the pectoral muscle immediately after he has made that flap. Next, the sternal flap is to be cut from the anterior surface of the breast, and then an incision carried round the sternal border of the gland detaches it completely from the trunk. Loss of blood is in some measure prevented by an assistant compressing the anterior intercostal arteries with his fingers placed over each intercostal foramen. Another should put a finger upon the mouth of any bleeding vessel, especially the branch from the axillary artery, which is often of considerable size. Bleeding arteries require to be twisted. The writer has not used ligatures for some time, and has never had a case of recurrent or secondary bleeding after torsion. The integuments should be brought together, and maintained *in situ* by plaster or some other means, according to the inclination of the surgeon. Compresses of lint should be adjusted along the edges of the wound to maintain the flaps and subjacent tissues in close apposition; but openings must be left at either extremity of the wound for the escape of discharges. If secondary hæmorrhage occurs, and the wound becomes filled with coagulum, it is advisable to remove all the dressings, clear away the coagula, arrest the bleeding, and rearrange the wound. Cicatrisation is greatly impeded by neglecting this procedure. After careful adjustment of the flaps and the employment of digital pressure to expel all air from between the detached surfaces, primary union takes place in almost every case.

SPECIAL DISEASES. DIVISION I.

Morbid Conditions of the Tissues composing the Breast.

Hypertrophy.—A breast having attained extraordinary dimensions, owing to the gradual growth of the tissues composing the glandular structure, is said to be hypertrophied. This disease is extremely rare. It is quite distinct from that functional enlargement of the organ which is associated with amenorrhœa. There are two conditions which produce a very different appearance of the whole of the affected part. In one, the breast is large, firm, resists the pressure of the finger, and projects in bold relief upon the thorax, the integuments being tense and smooth; in the other, the gland is pendulous, dangling loosely from the chest in whatever direction the trunk is inclined; it lies flat and flaccid on the hand, is weighty, tremulous, and constantly varying in shape; when pressed between the fingers, it feels as if its life was gone, were it not for its temperature and tint, since the fibre-tissue seems to possess no vital contractile force. Its shape is sometimes pyriform, the integuments are shrivelled and wrinkled, and the apex of the nipple is turned upwards towards the clavicle, instead of in its normal direction. The component masses of the gland are so loosely connected together that the fingers lie in fossæ between them, the whole contour of the organ being totally devoid of its normal and agreeable form. The nipple is generally small, sometimes quite undeveloped, and the areola is spread over a larger area than usual.

This disease commences soon after puberty, or in early adult life, in single women as well as in married. It would appear as if, the growth of the organ having been excited, this action is not controlled, and hence enormous bulk is attained. Both the breasts are affected; generally simultaneously, although, perhaps, they may not be of quite equal size. The general health and nutrition of the sufferer is sometimes good and is not at all impaired, until distress is occasioned by the incumbrance and weight of the masses. Usually the catamenial function is more or less deranged. The author has seen the pendulous hypertrophy accompanied by a new growth, an adenocœle, which he removed, but the morbid state of the organ continued. We may distinguish between this disease of the breast and others by regarding the age at which it is developed—for it is an affection of early life; the functional state of the organ; the commencement of the disease tracking back to the development of the gland at puberty; the participation of both breasts in the morbid action at the same time—for it very rarely happens that a new growth so forms in both; the tactile indications, remembering that occasionally a new growth may be superadded; the generally, at first, unimpaired health of the patient, and the absence of local suffering. Neither constitutional nor local remedies produce any marked benefit. Should the catamenial function be morbidly affected, all due attention must be paid to the fact, and remedies likely to improve its condition may be prescribed. Amputation of the larger of the breasts has been successfully performed; but it is a measure to be had recourse to only under most adverse circumstances. Nevertheless, in some of the cases after the operation the remaining breast diminished considerably. In a case reported by M. Bouyer, both breasts were successfully removed, the patient losing by the operation one-third of the weight of her whole body before its performance. After a critical examination of several of the recorded cases of a single large breast, we may be allowed to question the correctness of applying the term hypertrophy to them, and to doubt their being really examples of this disease. Doubtless in many the dimensions of the breast were caused by the development of a new growth, as in the case published by Dr. Ashwell in 1841.¹

¹ *Guy's Hospital Reports*, vol. vi. p. 203, with a plate. This proved to be a large new growth, an adenocœle; and it was subsequently removed by Mr. Stanley, in 1843. The tumour is preserved in the Museum of the College of Surgeons (Prep. 208).

We have selected for reference the following cases recorded within the present century, and have arranged them in two groups—1. Those in which the disease commenced at puberty. Hey, *Practical Obs. in Surgery*, 8vo, 3rd edit. 1814, p. 500; Cooper, *Illustrations*

Atrophy, or wasting of the secreting tissue of the breast, commonly takes place as life advances and the procreative functions cease. The gland is very generally replaced by fat, so that the outline and form of the organ is preserved. The ducts are always persistent, and sometimes contain a tenacious mucus.

Occasionally in early life the secreting tissue is so far atrophied that, even during pregnancy, the ordinary changes in the organ do not take place, and after the birth of the child there is a total absence of the secretion of milk. The breast often wastes when new growths are developed therein, and even in young persons adenocenes are sometimes seen to take the place of the normal organ. Very protracted lactation and rapid repetition of the function, in delicate women, exert a baneful influence on the fibrous structures, which interferes with the healthy form of the gland in after-life. And, in some persons, after weaning, the glandular tissue shrinks so remarkably that scarcely any breast remains; nevertheless, during a subsequent pregnancy, the normal changes take place and the organ performs its functions, in perfection. In fact, as a rule, a mother with breasts of this description generally proves a more efficient nurse than another in whom the large dimensions of the gland might be regarded as indications of its perfection.

Inflammation and its results.—The various kinds of this morbid action occur at every age and in all conditions of the organ. They rarely arise either before puberty, about that period, or during the inactive state of the gland. But, on the contrary, they are very common in the adult and during lactation. During pregnancy, and when weaning, inflammation very rarely happens; but it is more common during the former period than the latter. And, when developed at weaning, it is usually excited by an accidental circumstance—*e.g.* the death of the infant, or illness of the mother, necessitating the abrupt discontinuance of suckling. In the majority of instances it is secondary to local irritation, especially ulceration of the nipple, obstruction of a milk-duct, or a contusion; and, as an occasional source, we must notice a diseased state of the axillary lymphatic glands. Having stated that it arises, first, in the inactive stage of the organ, and secondly, at periods of its functional activity, we may next describe its effects in relation to those different conditions.

During infancy.—Soon after birth, in both sexes, although most commonly in the male, the mamilla frequently becomes swollen and painful, the skin around slightly pink, and there may be a serous fluid, or even milk, secreted, which oozes from the ducts. Nurses who indulge the propensity to interfere with the processes of nature, by ‘rubbing away the milk,’ too often excite inflammation, which is indicated by the usual local and constitutional signs, and sometimes passes on to suppuration. Even eight days after birth this rudimentary organ occasionally causes much pain from slight inflammation becoming developed around it, which cannot be assigned to manual interference. And in a female infant, three months old, we have seen an abscess in this region, the exciting cause of which it was not possible to discover, except it was constitutional delicacy. The mother of this infant stated that, unlike others, there was not in this one any secretion in the breasts after birth, and that, consequently, the usual means ‘to rub away the milk’ were not employed. We need scarcely say that, as a prophylactic measure, every cause of irritation must be carefully removed from the excited organ; even the friction of the dress against it should be prevented in delicate infants. With a tendency to inflammation, warmth and moisture may be maintained over the affected part by using the softest application, such as moist cotton-wool, or some medicated lotion may be advantageously employed—*e.g.* liq. plumb. diacet. dilutus.

At puberty.—Associated with the development of the breast in the female, in-

of Diseases of the Breast, 4to, 1829, p. 70; Huston, *Amer. Journ. Med. Science*, 1834, vol. xiv. p. 374; Malgaigne, *Gaz. des Hôpitaux*, 1844, p. 599. 2. Cases in which the disease commenced after the establishment of puberty, in married women and unmarried. Delfiz, Majendie's *Journal de Phys. exp. et path.* 1825, t. v. p. 396; Schaal, in *Rust's Mag. f. d. gesammte Heilkunde*, 1825, b. xix. p. 360; Cerutti, L., *Meckell's Archiv f. Anat. u. Phys.* 1830, p. 287; Hecker, *Med. Zeitung v. Verein f. Heilkunde in Preussen*, 1837; Skubersky, *Weitenweber's Neue Beiträge z. Med. u. Chir.* 1841, p. 42; Bouyer, *Gaz. méd. de Paris*, 1851, p. 301.

flammation very rarely occurs, although the gland often becomes exceedingly painful, and the nipple and areola of a deeper red. But after puberty, when the organ is developed but inactive, both acute and chronic inflammation arise; for which it is often difficult to assign a cause. Chronic abscess is certainly more common than acute. This disease occurs in delicate strumous girls; it usually commences as a hard, painless, defined swelling, with sometimes slight uneasiness. In this stage it may be easily mistaken for a new growth, until, as the tumefaction enlarges, it becomes softer and softer, and fluctuation is detected. Then it is supposed to be a cyst, as very little pain has been felt, and constitutional disturbance has not been excited. At last the swelling is punctured and the pus escapes. In this way the discovery of the contents of the cyst is frequently made, and all doubt as to the nature of the complaint is removed. Cases of this kind deceive even the most experienced surgeons. Operators, acknowledged to be the greatest adepts at diagnosis have proceeded so far even as to commence an operation for the removal of a new growth from the breast, which proved to be but a chronic abscess; and therefore the careful surgeon should always suspect the existence of a chronic abscess until there be most unequivocal indications that the disease is of another kind. In cases of this class the disease appears to depend chiefly upon some constitutional defect, and therefore the rule as regards treatment is to improve the general health. It would be idle to enter at great length into the treatment of this malady. Bearing in mind the anatomical disposition of the organ, and its relation to the surrounding structures, it demands no very special mode of treatment. We may therefore pass on to that kind of inflammation and abscess so commonly developed in the breast at the time it is an active secreting organ, or preparing to become one.

During pregnancy and lactation.—Inflammation rarely occurs whilst the breast passes through those phases which render it a secreting organ. At this time it is often very painful, and there may be slight vascular excitement; but inflammation is not developed unless some injury chance to be inflicted by sudden violence or continued compression exerted by the clothes.

It is, however, very common during lactation. Generally it happens with primiparæ; and, in a majority of cases, it is determined by either a defective development of the nipple or a morbid state of it. It most frequently arises during the first month after childbirth.

The examination of 149 cases of inflammation ending in abscess showed that in only 17 women the disease was not associated with lactation; whilst in the majority, 132, it arose in those who were suckling. In 118 cases, either inflammation or abscess occurred in more than half of those who had given birth to a first or second child, and nearly one-third were primiparæ. An inspection of the nipple showed that in 97 cases of abscess this important part of the gland was imperfectly developed in 48, and diseased in 19, whilst it was well-formed and healthy in 30. Thus we find half the cases associated with defective nipple; and adding to these the patients with unhealthy nipples, we have more than two-thirds of the cases of inflammation and its results complicated with, and probably excited by, malformations or diseases of the aggregation of the excretory ducts constituting that organ. As to the period after parturition when inflammation occurs, I found, in 116 cases, that it commenced during the first month after parturition in half of them, viz. 58 cases, and in a large proportion of these during the first week. In the other 58 cases, commencing after the first month, in 11 it began during the second month, in 8 during the third, in 22 between the third and eleventh, and in 17 between that month and the twenty-first. Now, as very few mothers continue to suckle for so long a time, it would seem that abscess depends very commonly upon protracted lactation, and probably the constitutional exhaustion excited thereby.

The above facts teach the following lessons, which, if fully accepted in that light, may prove of great importance, and save much misery. They should induce the surgeon to anticipate the probable result concurrent with the conditions described, and they furnish a substantial basis upon which to propose prophylactic measures in order to avert the ill consequences arising from them. Thus it behoves the medical

attendant upon a primipara to examine carefully the condition of the nipples ; and if there be any imperfection, to employ means to excite their development, or, at least, to prevent the gland-tissue from becoming so gorged with milk as to conduce to subsequent mischief. Occasionally diminishing the distension by removing small quantities of milk with a breast-pump will prevent lactic congestion, the forerunner of inflammation and its results. Also, it often happens, when the gland-tissue is much congested, that the orifices of the ducts in the nipple are more than usually inverted, and that relatively with a more empty state of the whole organ the nipple becomes more prominent. The opening of one or more of the ducts is sometimes obstructed by an accumulation of epithelium, which is indicated, according to Dr. Ratzenbeck of Prague, by a very minute white projecting translucent vesicle. The milk-congestion of that lobe, the duct of which is thus blocked up, may be relieved by the withdrawal of the cause producing it.

Semeiology and progress of inflammation.—The earliest deviation from a healthy state of the gland is usually indicated by more or less induration, which involves one or more of its lobes. Slight uneasiness in the act of lactation, or during the movements of the arm, often leads to its discovery, for in this stage (the first) the pain is not acute. Occasionally, patients state that a sensation of chilliness, or a shivering fit, preceded the discovery of the ‘lump, knot, or coring of the milk,’ as it is commonly called. In this stage, the secreting portion of the affected lobe is simply congested with milk, and especially the more solid portions of that secretion. The skin over the induration is not affected, and gentle manipulation of the part is tolerated without inconvenience. With very variable rapidity, in different cases, the induration increases ; more and more of the lobes are affected, until at last the whole organ becomes involved in the disease. This constitutes lactic congestion. It sometimes takes place with but slight inconvenience, caused at least by pain, and without exciting much constitutional disturbance. In other cases, the disease advances rapidly ; the skin becomes red, swollen, and even œdematous, usually over the primary induration ; great suffering is caused, and severe constitutional excitement aroused. As time passes on, the length of which cannot be fixed with any uniformity, suppuration takes place, and the pus collects either in the breast, behind it, or upon its cutaneous surface.

Hence the division of mammary abscesses into three classes : superficial or super-mammary, intra-glandular, and sub-mammary. Each kind is characterised by a peculiar train of symptoms and very marked local indications, which we must now describe.

The superficial abscess, bounded by the cutaneous surface of the gland behind and the integuments in front, generally pursues a rapid course, and is not attended with very severe constitutional disturbance. In very cachectic women, however, the action is not limited ; but it extends along the connective tissue around the whole gland, destroying it, and causing diffused suppuration, and, in rare cases, a widespread destruction of the skin. But in those superficial collections of pus, that fluid quickly makes its way towards the integuments, by the natural process termed ‘pointing,’ and the contents of the abscess escape. The usual local and constitutional symptoms accompany the morbid action, which it would be idle to describe here. (See INFLAMMATION, vol. i.)

Intra-glandular abscess, the result of inflammation affecting one or several of the component masses of gland-tissue, is attended by local and constitutional symptoms of much greater severity than the variety last described. The pus collects within the fascia of the organ. The local pain is often agonising ; the rigid texture of the gland-tissue, yielding slowly, compresses the inflamed structures, and the intense throbbing, burning heat, and heavy weight complained of produce sufferings with difficulty mitigated. The integuments slowly participate in the morbid action, and the whole breast sometimes becomes double the normal size before either redness or swelling takes place on the surface. At last, however, at a spot usually over the site of the primary hardness and most painful point, the integuments yield slightly to pressure, where there may be also slight redness and œdema. From this the superficial inflam-

mation extends, and, in a few hours afterwards, fluctuation of pus is felt. The constitutional symptoms are usually severe. After the first forty-eight hours from the discovery of the first hard spot, acute pyrexia is frequently developed, and accompanied sometimes with cerebral disturbance and excitement.

Sub-mammary abscess is characterised by the remarkable appearance of the whole organ. The breast seems to rest upon, or to be pushed forward by, something developed behind it; and, when slight pressure is used with the whole hand in a direction towards the thorax, the part feels as if it were resting upon an air-cushion or something elastic. This disease is generally slow in its progress; the local pain attending its development is commonly not so severe as in that last described, the redness of the integuments covering the breast is very slow to appear, and the nipple is often remarkably free from all disturbance. Constitutional reaction is not often excited until a somewhat late period; scarcely at all in some patients, until the fascia or the integuments, or perhaps the gland itself, become involved. The progress of the pus through the integuments is slow, and very often pointing takes place at several spots around the periphery of the gland; or the pus makes its way between the lobular masses of the organ, and an opening forms near the areola towards its sternoclavicular border, that part of the gland being the thinnest.

The treatment of inflammation must be conducted upon general principles; for those which are applicable in like conditions of other tissues of the body should be the guides for the administration of remedies when that disease affects the breast. However, a marked peculiarity of the organ affected arises from the fact that it is an active secreting gland in a majority of the cases; and the disease is often developed soon after child-birth, and therefore intimately associated with the puerperal state. In these circumstances, then, we have additional elements which require attention.

When merely a part of the gland is indurated and painful without redness of the skin, a careful examination of the nipple should be made with the view to detect any obstruction of a duct or irritation about the orifice of one. Should the gland become much congested, mechanical means must be employed to remove the milk. Suckling need not be abandoned; but care must be taken that the gland-tissue is really fairly emptied of its secretion. The application of an evaporating lotion, or of one containing liquor plumbi, made warm before using it, frequently gives relief. The arm of the affected side ought not to be actively used; and a bandage should be adjusted in such a manner as to prevent the weight of the breast dragging upon the affected part. If the patient lie in bed, the breast may be supported on her chest, or a pillow may be arranged between the arm and affected side, upon which it may rest—a method which, in some cases, is more agreeable than a bandage. Careful attention must be given to the condition of the alimentary canal, and a gentle aperient is often beneficial.

As soon as the skin becomes red, the local application of warmth and moisture is indicated. This principle may be carried out in many ways, the details of which it would be idle to relate here. The abstraction of blood, by means of leeches, may be useful at this stage; they should be made to bite at the periphery of the breast, nearest to the site of the inflammation, in preference to the part where the redness exists. The quantity of blood drawn must be regulated by the state of the general health of the patient, which commonly requires supporting rather than depressing. Nevertheless, in strong healthy young mothers, where the difficulty arises from deformity of the nipple, active local and constitutional measures are quite justifiable, and are frequently attended with great benefit. At the bedside, the practitioner has in fact, first, to establish clearly the cause of the inflammation; secondly, to consider carefully the constitutional condition of the patient; and the treatment of the case must be regulated by the indications afforded. One word of caution in reference to lowering the reparative powers of the patient. We believe that the practice is often carried too far, and that much greater advantage is gained by giving support at the time inflammation exists, not alone with the view to its resolution, but prospectively upon the chance of suppuration taking place. Cases of acute

inflammation of the breast during lactation have been successfully treated by covering the whole organ with collodion.

Abscess; how it is to be opened, when, and where.—The question is often asked, Is it advisable to open the abscess artificially, or leave the pus to escape by natural efforts alone? Should the pus be superficial, the local action circumscribed, pointing advancing without threatening destruction of much skin, and the constitutional disturbance trivial, the contents of the abscess may be allowed to escape by the processes of nature. But if the skin turns purple beyond perhaps an inch, and the cuticle peels off for a wider extent, the introduction of a lancet at the centre of the purple spot becomes necessary to prevent further extension of the mischief and gangrene of a large area of the cutis. The opening in an abscess of this kind should be free: a mere puncture will not suffice. It should be sufficiently large to allow the pus to escape readily; pressure to hasten its exit must be studiously avoided, that the walls of the abscess may collapse naturally; and the breast should be carefully supported with a bandage.

Abscess confined within the fascial envelope of the breast and between its component masses should not be interfered with too soon, unless the constitutional disturbance excited by the retained pus in its efforts to make its way to the surface be uncommonly severe. When, however, the skin becomes red and cedematous, a spot, softer and more yielding than the surrounding parts, may be generally detected. Very commonly this is discovered over the site of the primary hardness. Now, if the local pain be severe, the constitutional disturbance excessive, and the patient much exhausted by the tedious progress of the complaint, the introduction of a bistoury at the soft spot before mentioned affords almost instantaneous relief by diminishing the tension of the inflamed tissues, which was induced by the pressure of the fluid.

In cases of sub-mammary abscess the pus makes its way to the surface very slowly; the constitutional symptoms are not generally so severe as in the last-described variety; and it is in most cases desirable to seek the spot, from time to time, at which nature is effecting an opening for the escape of the pus. This most commonly happens somewhere around the periphery of the gland; rarely the pus burrows through it, in which case pointing takes place over that part of the breast where the gland-tissue is thinnest—*e.g.* in the quarter between the nipple and the sterno-clavicular articulation. In order that the pus may escape most freely, an opening at the lower border of the gland is considered preferable to one in any other part; but it may be as well to state that in this kind of abscess the disease is seldom cured after making one opening only. These are the cases in which numerous apertures are often formed; fistulæ and sinuses, traversing in several directions, burrow behind the gland and between its compact masses, producing an amount of suffering, and depression of the system generally, very difficult to obviate. When the pus points, ordinary rules suffice to guide the surgeon in the treatment of the case.

Other methods of emptying abscesses are employed by surgeons. Some prefer to remove the pus by means of a trocar and cannula, making at the same time a somewhat valvular puncture; and when all the pus has flowed, the sac is washed out with tepid water. The cannula is then removed, and the whole organ strapped up in order to keep the walls of the abscess in contact. This method is reported as successful in effecting that which may be termed the primary cure of abscess. Others, after emptying chronic abscesses, inject solutions of iodine; and a vulcanised india-rubber drainage-tube, introduced into the cavity of the abscess, is said to hasten cicatrisation. These methods of treatment are not, however, generally available in acute abscesses, but may be employed in those of slow formation and unconnected with lactation.

Treatment after an abscess is open.—For a few days it may be well, in some cases, to apply warmth and moisture to the surface of the breast generally; but we have not found any advantage to be gained by encouraging suppuration, as the long continuance of poulticing usually does. On the contrary, we prefer to cover the opening lightly with a small piece of wet lint or cotton-wool, over which very thin

gutta-percha is laid, to prevent rapid evaporation, immediately after the flow of pus has ceased ; and then to support the part carefully with a suitable bandage. The diet of the patient should be nourishing, not too stimulating, although there is no objection, if the patient be low, to allow some mild stimulant to be taken. Under similar conditions, tonics must be likewise administered.

Consecutive abscesses not unfrequently occur. This circumstance usually happens in those instances of general congestion of the whole organ before described. As a sequela of abscesses, sinuses sometimes remain a long time, being very difficult to heal. Stimulating injections, strapping up the breast with plaster, and applying a bandage methodically (p. 431), and, as a last resource, cutting them open, are means towards effecting cicatrisation.

Milk fistulæ will not usually heal until the secretion of the gland is arrested.

Chronic induration of the gland-tissue, now termed adenoma, may affect the whole of the gland, or only portions of it. The degree of hardness thus produced is sometimes sufficient to excite the alarm of the patient and the anxiety of the surgeon. A minute examination of the gland-structure thus diseased shows that those tissues of the organ in which secretion takes place—that is to say, the cæcal terminations of the ducts—are the parts principally involved in the morbid action. During the inactive condition of the breast, when its tissues are soft and yielding, although somewhat firm to the touch, the cæcal terminations of the ducts are scarcely recognisable in the field of the microscope. Here and there, perhaps, a trace of them may be discovered by small accumulations of epithelium. But when the breast-tissue is indurated, the cæcal terminations of the ducts are gorged with epithelium, the acini become perfectly distinct, and a somewhat excited state of the organ seems to be the cause of the development.

This morbid state is seen in breasts of all shapes and sizes ; the large, heavy, pendulous variety is thus affected as well as the small, atrophied, disc-shaped organ. When manipulating the first variety, the gland seems to be distinctly circumscribed, and it feels just like a great ball under the integuments ; in the last, the fingers may be insinuated beneath its borders, and the whole mass feels like a quoit covered with skin. When a single mass of gland-tissue is affected, or perhaps two or three neighbouring masses together, or in different parts of the same organ, the indurations resemble tumours formed by a new growth, and they are frequently mistaken for adenocæles or cancer. The induration is most distinctly felt when it is pressed between the finger and thumb, or the breast is grasped from side to side and raised from the pectoral muscle. When pressed flatly against the chest, it is imperceptible as a hard mass. In most cases complaint is made of severe pain, and in some nervous excitable women the suffering occasioned is described as agonising. The slightest touch is scarcely endurable, and any pressure upon the induration produces an immediate outcry of distress, of which the countenance of the patient is also an index. The cheeks are often suffused with a bright-red blush as well as the throat and neck, although occasionally the effect of the sudden pain is to produce the very opposite result, when the cheeks become pallid, the pulse small, and a sensation of faintness, nausea, and even syncope may occur. But the pain is not confined to the affected breast. Patients complain of its widespread distribution, and some state that it shoots up the neck, others behind to the back and especially the blade-bone, and often down the arm. The surgeon too will discover that the slightest pressure over the intercostal foramina, whence the mammary gland nerves escape from the chest, either the middle or anterior branches, induces acute pain, and that sometimes even a single branch is alone affected, whilst all the rest are not. And it may be observed that the filaments of the painful branch are distributed to the indurated part of the breast. The pain is commonly paroxysmal, lasting various periods of time, and recurring without any assignable cause. It will sometimes even cease to be felt in the breast first affected and pass to the other ; again change ; and thus alternate from side to side. There is not a trace of inflammation in the integuments. The breasts of unmarried women between twenty-five and forty years of age are most commonly affected ; and of the married, sterile women are much more subject

to this affection than prolific. General functional disturbance of the generative organs usually accompanies this state of the breast, sometimes indeed precedes it. The opposite derangements—amenorrhœa, menorrhagia, dysmenorrhœa, and commonly profuse leucorrhœa—are the manifestations. The general health is also much disturbed, the rest broken, and the nervous system highly excited.

The diagnostication is aided by the history of the case—*i.e.* by the age of the patient, her social condition, constitutional health, and functional derangement of the generative organs. Manipulation, methodically employed, also assists materially. If the nervous filaments be sought for and pressed upon, the pain induced is almost pathognomonic of the disease. When the hand is passed gently over the gland, nothing indicating the existence of a new growth is felt, which always happens when one exists; the induration is very distinct if compressed between the fingers and thumb, but imperceptible with the hand flatly placed upon the part.

The constitutional treatment consists in the employment of every measure calculated to improve the bodily health: thus, mild aperients, alteratives, various kinds of tonics, the mineral acids, iron, quinine, and in some cases sedatives, exert a very beneficial influence. As a topical application, the liquor plumbi diacetatis dil., an evaporating lotion, or even one slightly stimulating, may be employed. When the pain has not been severe, we have known instances in which the induration was dispelled after strapping the whole organ with plaster, having first covered it with ceratum hydrargyri comp., or strapping with emplastrum belladonnæ alone. All direct local pressure should be carefully removed; and if the breast be pendulous, it should not be allowed to hang loosely without some support.

Effusions of blood caused by contusions.—Injuries of this kind produce swellings of greater or less magnitude in the breast. If the blood be extravasated within the fascia of the gland, the skin does not always show ecchymosis. But the history of the case will generally aid in the correct diagnostication of the disease.

Of course such a swelling may show itself at any age after the development of the organ, and in whatever state it may be; therefore some difficulty may not improbably arise in distinguishing between a tumour formed by extravasated milk and one by blood, but galactoceles are not often associated with violence well known to have been inflicted, whereas the blood-swelling always is. The first is painless usually; the last is accompanied with considerable pain. Inflammation and suppuration rarely take place in these blood tumours; they generally diminish slowly, and at last disperse. A slightly stimulating lotion applied to the part hastens absorption of the blood.

Ecchymoses occasionally appear in the integuments over the breast in association with amenorrhœa; and discharges from the nipple of a blood colour escape, under similar circumstances, which must be carefully kept distinct from those which occasionally accompany carcinoma of the gland.

Hyperæsthesia.—Under the term more commonly in use, 'irritable mamma,' is understood an exalted state of sensation in the skin covering the breast, as well as of the gland itself.

The suffering which patients undergo is sometimes most intense. The very thought of a person touching the part adds to the torture, and even the gentle contact of the dress can be scarcely tolerated. The affected breast is usually larger than when in a healthy state; it is firm, conical, projecting; the skin is generally red, from its blood-vessels being congested; the nipple is prominent and appears swollen. This state of the breast is very variable from day to day, the pain being sometimes confined to one gland only, at other times occurring in both, and occasionally alternating between one and the other. It will also suddenly cease, and return again as unexpectedly and without any assignable cause. Nor is the pain confined to the breast; it extends to the spine, neck, shoulders, arms, and hips. Young girls are more frequently thus afflicted than females above the age of twenty-five. Generally this affection is associated with an utterly disordered state of every function, a nervous excitable temperament, and especially derangement of the catamenial dis-

charge, dysmenorrhœal, amenorrhœal, or the contrary. This condition is doubtless excited by sympathy with the pelvic generative organs, and may probably be excited by indulgence in depraved habits. Its treatment consists in enforcing strictly hygienic measures—all the excretions must be restored to a normal state, from which they generally widely depart—and the application of some soothing lotion at the moment of the more acute paroxysms of pain.

FUNCTIONAL DISORDERS.

Abnormal secretion of milk.—This anomaly relates to the age of the woman, and to a condition unassociated with pregnancy.

Cases are recorded in which the breasts of old women have secreted milk;¹ others in which the secretion was formed at a very early age² (eight years); and of some women, reputed virgins, whose breasts secreted a troublesome amount of milk.³

Agalactia, or want of lactic secretion, depends upon an organic imperfection of the gland, as already stated (p. 434), and occasionally upon constitutional causes. This secretion may be excited by the application of the leaves of the castor-oil plant to the breast,⁴ as well as by warmth and moisture, and the stimulus of the act of suckling.

Galactorrhœa.—This term expresses an excessive secretion of milk, which is constantly flowing away. It may happen during pregnancy and after weaning, either at the conclusion of a proper period or as the result of a sudden removal of the suckling.

These conditions usually affect delicate females, and are associated with some derangement of the catamenial function. Measures to improve the general health must be enforced, and such medicines as give tone and power to the system should be administered. An application of the extract of belladonna over the breast, or even strapping it with adhesive plaster, will in some cases be useful. We have seen the preparations of iodine and of iron, given separately or in combination, exert a beneficial effect in these cases. Dr. Laycock recommends hemlock, used as a poultice, and given internally with opium in pills.

Congestion with milk.—The gland sometimes becomes excessively congested with its own secretion. This seems to depend on the more solid constituents of the milk being formed without the serous. For the more fluid portion appears to be an important agent, not only in diluting the nutritious element, but in favouring its ready escape.

It is probable that the sensation experienced soon after the infant is placed to the breast, called ‘the draught,’ is produced by more blood being distributed to the gland, and a rapid development of serum taking place. In cases of the kind under consideration the breast assumes enormous proportions. It becomes of stony hardness. The skin is stretched, not much changed in colour at first; the nipple seems to be drawn in, but is rather imbedded in the skin, which is raised up around it, and flattened; the local pain is not severe; and although the mind is much disturbed by apprehensions regarding the nature of the disease and its ultimate results, the constitutional effects are not nearly so severe as, *à priori*, might be expected. The progress of the disease is excessively slow. Generally it terminates in inflammation and abscess. We may here observe that the morbid affection is usually confined to

¹ *Abridgment of Phil. Trans.* vol. iii. p. 80; Diemerbröck, *Anat. corp. Human.*; Riberi, *Raccolta delle Opere Minori*, 2 vols. 8vo, Turin, 1851; Livingstone, *Missionary Travels*, &c., in South Africa, p. 126.

² Baudelocque, *Art d'Accouchement*, tom. i. p. 188.

³ Riberi, *op. cit.*; Heister, *Obs.* clxxiii. p. 325; John Dix, in *Med. Times and Gaz.* p. 89, Jan. 1856; Braithwaite, *Retrospect*, vol. xviii. p. 376; Cases in *Lond. Journ. of Med.* vol. i. p. 85.

⁴ The *Lancet*, Sept. 1850; *Edin. Monthly Journ. of Med. Science*, Oct. 1850; *Lond. Journ. of Med.* vol. ii. p. 951.

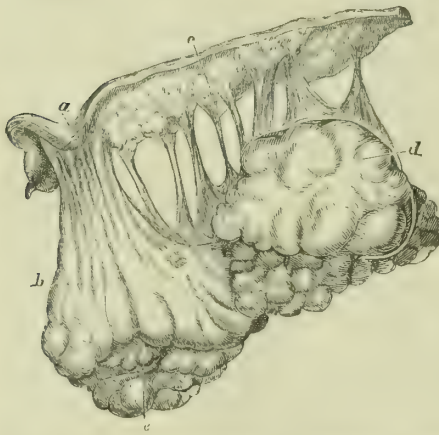
one breast, and that the function of the other one is performed in the most healthy manner. Also, that we have seen cases in which the gland, after regaining a healthy condition, was competent to the performance of its function at a subsequent parturition. The disease for which this one is most likely to be mistaken is carcinoma. But that disease is so excessively rarely developed during suckling, that the bare suspicion of it may be at once banished; especially if undoubted evidence can be obtained that there was no tumour in the breast before the birth of the child. The plain fact that the morbid state of the gland is immediately associated with the activity of the organ is, when accepted as negative evidence, almost pathognomonic of the nature of the diseased action. The treatment consists in strapping the whole breast with adhesive plaster, in the application of an ointment of iodide of potassium, iodide of lead, or the tincture of iodine, and in improving the general health.

SPECIAL DISEASES. DIVISION II.

New Growths, forming Tumours, the Elements of which more or less resemble those composing the Gland.

Adeno-sarcoma.—This term is employed to indicate a new growth, the tissues of which closely resemble those of the breast-gland itself. It is synonymous with the following designations: ‘Chronic mammary tumour,’ Sir A. Cooper; ‘Pan-

FIG. 94.—Adeno-sarcoma of Mammary Gland; the breast and the new growth dissected to show their relations to one another. Removed from a single woman, æt. 26. Six years’ growth. (Guy’s Hospital Museum, 22927.)



a, site of nipple; *b*, breast-gland; *c*, suspensory bands between skin and growth; *d*, new growth surrounded by its fibrous envelope; *e*, several small cysts with mucous contents.

creatic sarcoma,’ Abernethy; ‘Tumeur adénoïde,’ Velpeau; ‘Corps fibreux,’ Cruveilhier; ‘Hypertrophie partielle,’ Lebert; ‘Mammary glandular tumour,’ Paget; ‘Hydatid disease of the breast,’ Sir A. Cooper; ‘Carcinoma hydatides,’ Sir C. Bell; ‘Sero-cystic sarcoma,’ Sir B. Brodie; ‘Cysto-sarcoma,’ Müller; ‘Tuberous cystic tumour,’ Caesar Hawkins; ‘Proliferous cysts,’ Paget. Such a variety of names is sufficient to indicate the extreme diversity of outward form seen in these growths. Following their structural arrangements, we may make such a natural division of them as to include in three principal groups all the varieties met with in practice.

The accompanying woodcut demonstrates the relation of such growths with the mammary gland.

In the *first group* the growths are compact, dense, firm, fibrous, lobulated, and invested by their own fibrous capsule. The varieties in this group consist

of new growths, in which the observer may detect ducts, sinuses, and even the secretion peculiar to this gland; of others, very succulent, in which ducts are traceable in progress of development; and of those not succulent, very fibrous, crisp, dense, minutely lobulated and possessing the caecal terminations of the ducts only. The surface of a section of the tumours in this group shows a very variable arrangement of the elementary structures. In some it is quite smooth, divided into larger or smaller lobes, and compactly united together by connective tissue; in others it is broken up by fissures running in all directions and without any definite order; whilst in others, the surface is as irregular as it is possible to conceive, and appears as if the minute lobules would drop off from the general mass.

In the *second group* are cystoid¹ formations having growths within them which appear to spring from their walls, are floating and pedunculated, or sessile, and have very little connective tissue between them. These intracapsular growths are often bathed in fluid. Variety appears in this group by the tumours being composed of large, lobed, pedunculated masses, not connected together, although each lobe consists of lobules containing acini and the caecal terminations of the ducts, together with connective tissue. In other specimens the small lobulated masses are attached to membranous septa from which they are pendent; and in others sessile masses are dispersed upon the wall of a large membranous capsule which contains the characteristic serum. This fluid is usually of a pale yellow tint, tenacious, adheres to the fingers, and draws out in threads. Any deviation from this colour is due to the admixture of colouring matter from the blood.

In the *third group* we arrange those cystoid formations referable to the dilatation of the ducts or sinuses, and connected with them, which contain growths apparently springing from their walls and composed of tissues resembling those of the gland. Sir B. Brodie first described them, and they are very rare. ('Lectures on Pathology and Surgery,' lect. vii.) A drawing of a very remarkable specimen of this disease

FIG. 95.



The woodcut represents a fine example of the combination of the solid and cystiform growths developed in the breast of a middle-aged woman. The whole tumour was very large, and was removed by the late Mr. Aston Key. The wasted mammary gland overlies the growth on its left, and the nipple and ducts are indicated by the letters *a*, *b*. At the right of the tumour the integuments had ulcerated, and the letter *c* points to the growth projecting slightly through the hole in them. (The drawing and preparation are in the Museum at Guy's Hospital—No. 402⁷⁵; 2294.)

is published by Dr. H. Meckel in the 'Illustrirte Med. Zeitung,' 1852, b. i. It is the finest one delineated.

Adenocelas usually commence as a hard nodule upon the cutaneous surface of the breast, in its substance, at its border, or behind it. In some instances their mobility and isolation from the organ are aids towards diagnostication; but when they are imbedded in the gland, or developed behind it, these features are not recognisable.

¹ These so-called cysts resemble much rather the arrangement of the capsular ligaments of joints attached around the articular ends of the long bones than genuine cysts. It would be much more easy to comprehend the nature of both true cysts and of these envelopes of the new growths, if the word 'cyst' was exclusively restricted to a circumscribed cell or cavity bounded on all sides by a continuous membrane. In these adenoid growths, for the most part it is the envelope or capsule of the new growth, detached from its surface by the accumulation of fluid simply, which constitutes the so-called cyst. As this fluid is either absorbed or not secreted, the growth seems to encroach upon or fill up and obliterate the cyst; but without the growth increasing, if the fluid disappears, the capsule becomes compressed upon the surface of the new growth, and is more or less adherent to it.

When the new growth has reached a considerable size, the true breast is frequently atrophied. Rarely both the right and left breast have tumours developed in them, and it is uncommon to meet with two or more in the same organ. We have been unable to prove that one breast is more liable to this affection than the other. A patient was, however, under my observation, in whose breast numerous tumours were developed, varying in size from half an inch in diameter to two or three inches. The rapidity of their growth varies greatly in different patients. Those possessing a cystoid character increase more rapidly, as a rule, than the dense, compact, fibrous structures. In several museums enormous masses of all kinds are preserved, which weigh many pounds. The integuments usually accommodate themselves to the stretching to which they are subjected without ulceration taking place, although in some few instances we have seen them become gradually thinner and thinner over a single cyst, and ulcerate. This allows the escape of the serum, after which a hole continues in the skin, the features of which are distinctive of the disease beneath. The edges of the ulcer are thin and lie flat upon the intracapsular growths, neither inverted nor everted; they are not even adherent to it, but can be raised from it with facility. In one instance, and where the tumour was not large, the integuments sloughed, after which the whole mass projected through the opening in the skin and formed a red fungating growth, which assumed the aspect of cancer. As a rule, the more dense and fibrous kinds grow slowly. I lately removed one of twenty-five years' growth which was only about four inches in diameter. When in the gland of a young girl, their rate of progress seems commonly to be from about half an inch to one inch in twelve months. Such, at least, is the nearest estimation I can form, after watching them in patients who would not submit to their removal. Having attained a moderate size, their growth sometimes ceases. Those tumours associated with cysts always grow the fastest. One notable exception to this we have observed. It occurred in a maiden aged twenty-three, from whom the late Mr. Nathaniel Ward removed a tumour of two pounds weight, which had grown in about eight weeks, according to the statement of the patient. It was chiefly composed of succulent fibre-tissue and the epithelium of the mammary gland-ducts and cæci.

Sudden and rapid increase in size occasionally happens in these cases, accompanied with more or less redness and vascular congestion of the cutaneous covering. This change is due to two causes operating upon the tissues of the new growth. One is inflammation, passing on to destruction or necrosis of its central portions; the other depends upon intracapsular hæmorrhage. A case of this kind is reported by Mr. Bryant.¹ In another case,² under the care of Mr. Kellock and the writer, a sudden enlargement of the tumour was observed a few days before parturition. The growth was of several years' development; and when removed a large cyst was found in it containing a mixture of milk and serum.

Growths of the firm, fibrous kind are frequently developed behind the true gland, which is atrophied. The woodcut on the following page displays the arrangement of the tumour thus disposed. It was formed behind the wasted breast of a single woman, 43 years old, and had been observed about three months. The removal of this tumour was effected fifteen years since, and the patient is at this time quite well.

These tumours are developed at any age, about puberty or subsequently. Sometimes they form simultaneously with the development of the gland, rarely with the changes taking place during pregnancy, but most frequently at the stage of passive maturity of the breast. Thus, of any large number of cases, the third decade of life, which includes the ages between twenty and thirty years, offers the majority of examples. But care must be taken to note the age of each individual at which the tumour was first observed, and not that at the moment of examination. The writer found the proportions to be as follows, in 125 cases, from birth to fifty years old. During the first ten years there was not a case; from ten years to thirty, 90 cases; from thirty to fifty, 35. In a very large majority of the cases, the women were single when the tumour was first noticed; and when married women were the sufferers,

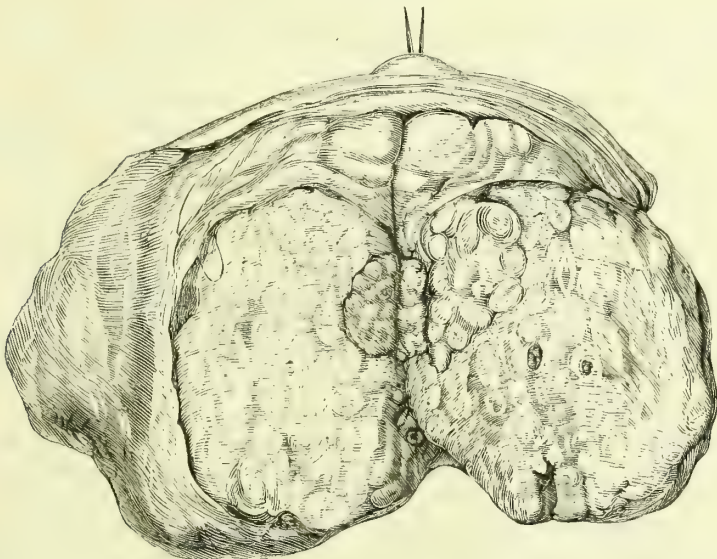
¹ *Trans. Path. Soc.* vol. xlii. p. 222.

² *Ibid.* vol. ix. p. 386.

the majority had been prolific. The patients were generally remarkably healthy. Very little inconvenience is caused by the growth in its early stage; indeed, very often the patient is only made aware of its existence by accidentally touching it. In a very few cases the discovery of the 'lump' was preceded by a contusion. Just before the catamenial period a little pain may be felt; but that, perhaps, does not exceed the usual irritability of the organ prior to its recurrence. Even when of great magnitude and their bulk intolerable, the freedom from pain is remarkable. It is right, however, to state that in a few cases we have known the patient to complain of severe pain; and that, in one instance, with this accompaniment, a filament of a nerve was traced into the new growth. The general health of the sufferer is unaffected in the first instance; but at last the bulk of the growth, and the mental anguish induced by anticipation of its results or necessity for an operation, prey upon the constitutional vigour of the patient, and it becomes impaired, whilst, at the same time, the facial aspect is indicative of depression and anxiety.

Of recurrence and alternation of these growths after removal.—The growths classed together in the first group very rarely reappear after excision. We have

FIG. 96.



A section of the tumour is represented, enclosed in a well-marked envelope. Overlying it, and also on its left side, is the atrophied breast, and at the top the nipple is seen, with two bristles projecting from the mouths of the ducts. (A coloured drawing and the preparation are now in the Museum at Guy's Hospital—Drawing 404^s; preparation 2299^c.)

never seen a recurrence in a patient in whom the tumour was developed before thirty years of age. But in older women, and especially when the tumour resembles those constituting the second group, recurrence is not infrequent, particularly if the entire mammary gland has not been carefully removed with the tumour. The truth is, that the more closely the tissues of these growths resemble the elements of the fibro-plastic formations, the greater will be the probability of their reappearance locally, and, we may also add, in one or other of the internal organs. An interesting feature of those cases in which the mammary growth has been repeated consists in the varieties of the first and second groups alternating with each other. For example, the first growth may be solid, firm, fibrous, and its section resembling the cut surface of the mammary gland; but the second tumour shall have the cystoid formation; whilst a third may assume all the characteristics of the first. And often, in different portions of the same tumour, these growths are found associated together, invested by a common envelope. Do we not in these loosely constructed growths recognise the propriety of applying the term 'capsule' to the fibrous membrane surrounding the adenoid growth, rather than adhering to the word 'cyst,' which carries one away

from the relations really subsisting between the capsule and the new growth within it?¹

Diagnosis.—The age of the patient and her healthy aspect; the shape of the breast, the locality of the growth, in many instances, its firmness, mobility, and freedom from pain, except perhaps after pressure, are the chief points from which aid is derived in correctly diagnosing the fibrous compact varieties of adenocoele, developed in the breast of maidens *before* thirty years of age. After this period, the cystoid varieties most commonly prevail. These tumours are characterised by their nodulated and lobulated surface, in which irregularity of course the integuments participate, so that the uniform roundness of the surface of the breast is marred. The elevations and depressions correspond with the collections of fluid and masses of solid new growth. Often, when the finger is pressed over the most prominent, the fluid can be displaced, and the indented surface of the intracapsular growth detected by sight as well as by touch. A combination of these capsules with their solid contents, in larger or smaller masses, together with perfectly solid growths, can be diagnosed by manipulation. In some cases the bold relief of the tumour upon the thorax, and its striking projection against the integuments, as if it were ready to burst through them, is highly characteristic, especially in marking the important distinction between an independent new growth developed in the organ and those new formations which, infiltrating the tissues of the gland, do not essentially interfere with its normal outline.

The *prognosis* of this tumour is for the most part favourable. When the growth belongs to the first group, it is always so. But when the fibro-plastic elementary tissues appear, the surgeon must bear in mind the statements before made, and pronounce with caution.

The *treatment* consists in removing the tumour by excision. We have never seen the slightest advantage gained by local applications, nor are we disposed to admit that a genuine new growth of the nature before described is ever absorbed. Isolated and circumscribed lobules of the true gland, which from their hardness and mobility closely resemble these new growths, certainly disappear when the healthy condition of the gland is restored; but is a genuine new growth ever absorbed? We believe not.

On small tumours the operation is very simple. The integuments should be stretched over the growth tightly, and the point of the scalpel inserted sufficiently deep to penetrate its anterior surface to the depth of about a quarter of an inch. The capsule is thus cut by drawing the edge of the scalpel through it. Its handle is next made use of to detach the connections between the capsule and the growth, and where the fibrous tissue enters between its component lobes the blade is used. After this manner it is easily enucleated, without cutting the breast-gland itself. When the adenocoele is covered anteriorly by the gland-tissue, the operator must make an incision through that structure, and open the capsule as before described. The edges of the wound are to be kept in close apposition with plaster. This proceeding should be adopted in the majority of patients under thirty years of age. As a rule, however large the growth, the gland should be sought out and preserved, if practicable, in young child-bearing women.² After thirty-five, unless in exceptional cases, we deem it preferable to remove the entire breast with the growth.

Duct-cysts.—Perfectly closed cysts, and others so called, but having an opening communicating with a duct, which in some instances is so large that the swelling assumes rather the character of a dilatation or bulging of the walls of the tube, are

¹ Brevity being compulsory, the reader is referred to a paper on Adenocoele in *Guy's Hospital Reports*, 1855, in which a large number of cases is reported by the writer.

² The reader is referred to Mr. Stanley's case, Preparation No. 208 in the Pathological Museum at the Royal College of Surgeons; the report of the case in *Guy's Hospital Reports*, 1841, p. 203; and its subsequent history in the volume for 1855, p. 144, case v. Also another case, with a milk cyst, p. 139, case i., in the same book. This last-mentioned patient is now (1880) well.

frequently met with in the breast. Their contents more or less closely resemble the mucoïd secretion found in dilated ducts. Hence their assumed origin and the term by which they are designated, duct-cysts, retention-cysts, or, from the nature of their contents, mucous cysts.

The wall of the cyst is usually thin, firmly united to the surrounding parts, and consists of fibre-tissue. Its interior is smooth, and covered with squamous epithelium. The contents are either a thick tenacious mucus of a dull green, yellowish, or brownish tint, and slimy, greasy consistence, which renders water turbid, but does not readily mix with it; or, if the cyst be large, the fluid is more serous, with an admixture of blood causing its colour to assume a dark red, brown, or blackish hue. Laminae of cholesterine may be seen in the fluid. Sometimes only a single cyst forms in one breast; in other cases cysts abound in one or both. Indeed, one rarely fails to find some of them of minute size, if the gland of a woman of middle age, and who has suckled several children, be examined after death. Of course, examples of this kind give no trouble; but when the tumour reaches one or two inches in diameter, and produces a hard fluctuating swelling in the breast and a blood-coloured fluid oozes from the nipple, considerable alarm becomes excited. Such swellings are developed in any part of the breast. Most commonly, however, when large they are placed superficially, near the areola, and in the neighbourhood of the larger ducts. When numerous and minute, the posterior and peripheral regions of the gland seem to be the parts usually selected for their development.

This disease is always met with in the passive state of the gland, and in adults who have reached or passed the middle period of life. It occasionally occurs in single women, but most commonly in those who have been mothers and suckled children, although married but sterile women are not exempted. In different cases and at various stages of the growth the accompanying pain differs much. In some, this morbid condition is painless. When the cyst is very large—a condition which, however, rarely happens—the fluctuation of its fluid contents is very distinct; and when small and numerous the same may be detected in the separate cysts, although they often feel so very hard as to deceive the careless observer. By gentle compression of the cyst the fluid sometimes escapes from the nipple, which occurrence may almost be accepted as pathognomonic of this disease, and especially, too, if the cyst can be thus entirely emptied. But should a solid substance be felt after the escape of the fluid, the probability is that some other disease exists, associated with the cyst. As the cyst enlarges, the integuments covering it become thinner and thinner, until the coloured fluid it contains produces discoloration of the skin. Such altered colour of the tegumentary texture, from that circumstance alone, is a notable fact, and one which must not be confused with the colour depending upon congestion of its blood-vessels, or infiltration by inflammatory or other products. The tint of the overlying skin is either pink, red, purple, or brown. At length ulceration of the skin takes place, if the disease be allowed to take its course, and the fluid contents of the cyst escape. In some cases the opening heals; but, as the wall of the cyst remains, it soon becomes again distended with an accumulation of fluid. We have known this operation to be repeated over and over again, occupying a period of several years, and merely giving rise to trouble and annoyance.

This disease being of purely local origin and usually occurring at a period of life when the organ is no longer required, two methods of treatment are offered for selection. The palliative treatment consists either in emptying the cyst by compression, when its contents flow freely from the nipple, or by making use of a trocar and cannula for the same purpose. When several cysts exist, a radical cure can only be effected by the removal of the entire breast. If only one cyst, incision and exciting inflammation of its walls will cure it. All external local applications are unavailing for the cure of the disease; but if a single closed cyst exist, it may be emptied, and a drachm or less of the tincture of iodine injected and allowed to remain there. Obliteration of the cavity sometimes follows this treatment. When the disease originates as above described, to the exclusion of every other, the prognosis is favourable; but it cannot be denied that a great tendency to the development of these cysts

exists in association with carcinoma. In certain cases, therefore, a guarded prognosis is desirable. Preparations illustrating this disease are to be seen in the College Museum, Nos. 2742, 2744; and in Guy's Museum, Nos. 2290⁵⁵, 2290⁶³, and 2290⁷⁰.

Galactocele—a milky tumour, or a swelling caused by rupture of the milk-tubes and escape of their contents into the surrounding connective tissue, or dilatation of a lacteal duct or its sinus from obstruction—is rather a rare disease and always developed during the active state of the organ. If it occur at an early period of lactation, and in consequence of rupture of a large duct or one of the sinuses, fluctuation is perceptible in the tumour, which forms quickly and increases rapidly and distinctly during every time the infant sucks. On the other hand, should the extravasation proceed slowly, but little observation is taken of it; and having attained variable dimensions, the tumour sometimes remains without alteration for some time.

These cases being rare, the following instance is here introduced. A very healthy-looking married woman was twenty-two years old when her first child was born. Soon afterwards a tumour formed in the left breast, which after five months' duration was punctured, and serum escaped. She did not suckle with that breast. She gave birth to six more children, and at each parturition the tumour increased in size, but diminished as soon as lactation ceased. She came to me with a tumour of thirteen years' duration. It was soft, globular, and somewhat nodulated. An incision was made into it, when ten ounces of thick cream flowed away. The wound quickly closed by granulation.

The serous portions of the milk being absorbed slowly, the more solid, fatty constituents remain, causing the swelling to decrease and to become firmer. It may at last feel quite hard, the cyst-wall becoming rigid and crisp, which depends upon the deposition of earthy salts. In this stage a difficulty may arise in distinguishing the precise nature of the tumour. The swelling, during its formation and subsequent progress, is unattended with pain; the colour of the overlying integuments is unchanged, and the general health is not affected.

The diagnostication of the swelling is made, when first formed, by calling to mind the condition of the organ at the moment of its development; its sudden formation during suckling, and the changes produced in it concurrently with that act; the fluctuation; the unaltered colour of the integuments; and the freedom from constitutional disturbance. At a later period, the surgeon must be guided by the history of the case, its negative indications, his experience of other tumours in the breast, and by manipulation.

The treatment consists in incising the integuments and the cyst, allowing the free escape of its contents, and exciting the wound to heal by granulation.

A preparation showing the lactiferous tubes dilated and filled with milk is preserved in the College Museum, No. 2741; and others, showing a cyst which contained milk, in Guy's Museum, No. 2290⁶⁰, one a mass of casein, 2299⁴⁰, and 2290⁵⁹.

Sero-cysts are characterised by the nature of their contents, the globular outline of their form, the simplicity of their structure, and their harmless influence. The cysts so commonly found associated with the new growths termed adenocoele are designedly excluded from this category, as their contents are peculiar and characteristic.

The fluid of the true sero-cyst is limpid, and nearly colourless, or very pale yellow, or light brown, and sometimes just tinted with the colouring matter of the blood. It is clear, occasionally very slightly turbid, and never tenacious. It shows an alkaline reaction. Neither the application of heat, unless the fluid be very alkaline, nor the admixture of nitric acid, causes any coagulation, although a very slight flocculent precipitate may subside as the liquor cools. The cyst-wall is very thin, composed of fibre-tissue, firmly attached to the surrounding parts and lined with squamous epithelium. It is always perfectly closed, and never communicates with a duct. Usually a single cyst only is found. Its existence is discovered by the patient, whose attention is drawn to a tender spot, perhaps, where the finger detects

a small hard 'lump.' This discovery may have been made some time after the receipt of a contusion in the region, which merely produced temporary pain, and was subsequently forgotten. Other cases have occurred, in which the patient was totally unable to assign any local cause. As the fluid slowly accumulates the tumour progressively enlarges, and if seated superficially, elevates the skin, producing therefore unusual fulness of the affected organ. If it be near the nipple, that organ is sometimes pushed aside; and if the maiden state of it exists, it may be flattened out and lost to touch, although traceable by sight. It is never really retracted. The skin at last becomes much stretched over the tumour, without showing any other marked structural change, and by a careful adjustment of a strong light, the surface of the swelling appears translucent. Fluctuation is now distinct, together with the characteristic vibration of a circumscribed collection of fluid when gently and suddenly tapped with the finger. By degrees, the pressure of the fluid acting upon the skin, its vessels become congested, and sometimes its capillaries dilated; but there is little really inflammatory action until the last moment. Then ulceration takes place at a very small spot, the fluid flows out, the cyst collapses, and a serous scarcely coloured discharge continues to escape. That aperture sometimes closes, and never re-opens; in other cases, the processes above described are all repeated. These cysts are developed at a somewhat earlier age than those termed 'duct-cysts'—between forty and fifty. They are generally painless; but in nervous irritable women they are sometimes described as being painful. The general health is undisturbed, and the catamenial function normal.

The treatment consists in emptying the cyst with a trocar and cannula, after which an embrocation may be applied over the part, consisting of hydrochlorate of ammonia, spirits of wine, and camphor mixture. Sir B. Brodie states¹ that he has cured cases, probably of this kind, by the mere application of a lotion composed as follows: \mathcal{R} . Sp. camph. sp. tenuior., ana. fl. oz. ijss.; liq. plumb. diacet. fl. oz. j. This must be applied on a piece of flannel, once folded, over the site of the tumour, renewing it six or eight times in the day and night, until the skin becomes inflamed; then desisting for two or three days, and again using it. He adds that 'three or four weeks,' and in some cases 'some months,' elapse before this treatment is successful in effecting a cure. In numerous cases which I have myself treated, a single puncture sufficed for cure.

Lipoma and excess of fat.—Masses of adipose tissue are occasionally developed on the breast, within it, and sometimes behind it. As age advances, fat is frequently generated in the place of the gland-tissue, so that what appears to be a largely developed organ really consists of fat-tissue only, through which a few ducts radiate from the nipple.

But in early life, tumours composed of fat (true lipoma) have been removed from the breast.²

Mr. Roper, of Croydon, sent to the Museum at Guy's Hospital several pounds of fat (Preparation 2300⁶⁰) which had been growing in the site of the mammary gland for fifty-eight years. A tumour was first noticed by the woman in her thirtieth year. She died at the age of eighty-seven years, having been merely troubled with the bulk of this pendulous tumour, which measured twenty-three inches around its largest circumference. In its centre there was an irregularly shaped piece of bone. The same collection contains a portrait of the patient and tumour taken during life.

At an early age, and in persons disposed to obesity, these organs become enormously loaded with fat.

Vascular growths, very rarely met with pure, are generally associated with car-

¹ *Lectures Illustrative of Various Subjects in Pathology and Surgery*, 8vo. 1846, lect. vii. p. 156.

² Remarkable cases of lipoma are recorded, as follows: Sir A. Cooper removed more than fourteen pounds of fat (*Illustrations of the Diseases of the Breast*, p. 67); and another case, p. 68. Sir B. Brodie relates a case in *Lectures on Pathology and Surgery*, p. 271. Warren excised eight pounds of fat (*On Tumours*, p. 228). Dr. Hegetschweiler's *Inaugural Dissertation*, Zürich, 1865. Pitha and Billroth's *Chirurgie*, bd. iii. 2 Abth. s. 85.

cinoma. That is to say, the new growth contains a large number of vessels, and bleeds freely when wounded. The case published in the 'Medico-Chirurgical Transactions' (vol. xxx.), which is reported by Mr. Image, may be referred to. There is also a case related in the 'American Journal of Medical Science,' No. xxxv.

Neuromata are developed on the cutaneous nerve-filaments, as well as probably on those within the breast. Their presence is recognised by the usual indications, which require no special mention here.

Enchondroma and osteoid growths.—New growths of tissues resembling those constituting special systems of the body are very rarely found in the breast. Thus, in my experience, tumours composed of either cartilage or bone are very rare.

Sir Astley Cooper relates the case of a woman, thirty-two years old, who had observed a tumour in her breast for fourteen years. When removed, the growth consisted of two portions: 'the larger portion of it had the appearance of that cartilage which supplies the place of bone in the young subject; the remaining part was ossified.' Also Prof. J. Müller writes,¹ in reference to four cases of enchondroma: 'In all of these four cases the parts affected were glandular structures, namely, in one instance the parotid gland, in another the *mammary gland*, and in the remaining two the testicle' (Dr. West's trans. p. 102). Rindfleisch² states that small nodules of cartilage are repeatedly found in the breast.

In old books we find reports of cases in which bony masses or concretions have been found. In old women, and in cases of extreme atrophy of the breast, the arteries are not uncommonly converted into bony tubes (see preparations in the Museum of the Royal College of Surgeons, 2811, 2812, and one in Guy's Hospital Museum). Of earthy concretions there are several preparations in the Museum of the College ('Path. Cat.' vol. iv. p. 342).

SPECIAL DISEASES. DIVISION III.

New Growths composed of Elements foreign to the Normal Tissues of the Body.

Hydatid cysts.—Cysts containing entozoa are occasionally met with in the breast.

Two cases have been seen by the writer. One of them occurred in a woman fifty-one years old; the other was twenty-nine at the time of the operation for the removal of the disease. Both were patients in the hospital. In the elder of the two the swelling in the breast had existed eleven years; in the other one six years. They both enjoyed very good health. The tumours measured about three inches in diameter; they were distinctly circumscribed, firm, painful when pressed, and fluctuation was very distinct. In one case Mr. B. Cooper removed the whole breast, together with the tumour; in the other, Mr. Cooper Forster removed the cyst and its contents only. The large sac containing numerous globular hydatids was very characteristic, and with the aid of the microscope the tentacles of echinococcus hominis were apparent in both instances. We are unable to distinguish between these cysts containing entozoa and others filled with serum or even pus; but the length of time which the tumours have existed, their slow increase, and painless nature, together with the negative evidence to be acquired by sight, touch, and the history of the case, should dispose the surgeon to open the cyst freely before taking away the whole breast.

Fibro-plastic growths; in German nomenclature sarcoma.—Under this term we include a class of new formations, the elements of which are nucleated cells of a fusiform or oval shape. The tumour increases rapidly, and becomes much identified with the breast, although the gland-tissue is not infiltrated with the new elementary structures; the integuments ulcerate, and allow a fungating, sprouting growth to burst through the opening. This disease is not very commonly developed in the breast. Sometimes it is associated with adenoid growths, and springs up in the gland of rather youthful women, who seem to be in the enjoyment of remarkably good

¹ *Ueber d. feinem Bau u. d. Formen d. krankhaften Geschwülste*, fol. Berlin, 1838.

² *Path. Gewebelehre*, 4te. Aufl., § 601.

health. Judging from the cases which have fallen under the observation of the writer, the recurrence of the growth is almost certain to ensue after removal, and the probability of the viscera of either the thorax or abdomen containing identical growths is almost equally great. It chiefly differs from the adenoid tissues in being developed at a rather later period of life, in the rapidity of its development, and by assuming externally some of the appearances of carcinoma. In truth, it has not perhaps sufficiently characteristic external indications to enable a surgeon to distinguish between it and carcinoma during its growth, but its elementary constituents differ widely from those of carcinoma. When not interfered with, the tumour often attains enormous proportions, and sometimes the centre softens down, or the whole mass sloughs. It is more vascular and succulent than carcinoma, and when ulcerated often bleeds profusely. The glands of the lymphatic system of the breast are not involved in the disease, even at the latest period. In our experience the removal of the growth has only been attended with temporary advantage, yet we do not hesitate to sanction this step, as it is the only one by which the patient has a chance of being saved from acute local suffering and a speedy death.

Colloid growth.—This new formation, termed by Prof. Müller ‘collonema’ and ‘carcinoma alveolare,’ is very rarely found in tumours of the mammary gland. In outward appearance, the new growth termed by Virchow ‘myxoma’ closely resembles this one. Most specimens of the disease have been taken from other parts of the body. We have seen but two examples on living persons, and there was nothing sufficiently characteristic then to lead to its identification. But it is quite the contrary when a section of such a growth is examined. There is not one so marked, so distinct, so easily recognisable. The transparent jelly-like substance is arranged in compartments, the walls of which are formed of a delicate fibre-tissue. In the specimens we have seen the colour has differed, but that has merely been owing to the admixture of the colouring matter of the blood. Very little change takes place in the appearance of the section after immersion in dilute rectified spirits of wine, but the jelly oozes out slightly and projects from the alveoli, forming a delicate flocculent surface. There seems to be a tendency to local recurrence in these growths, and therefore the whole of the affected organ should be removed; especially, too, as preparations show that isolated centres of the growth are disseminated freely around the principal mass.

Carcinoma, a disease generally known by the term ‘cancer,’ is more commonly developed in the breast than any other growth. It is found under three very distinct forms. First, the infiltrating kind; secondly, the tuberous; thirdly, the cystiform, or associated with a cyst or cysts.

In the first variety, the normal tissues of the breast, whether in a healthy condition of passive maturity or more or less atrophied, appear to be infiltrated with a fluid and nucleated cells. If the diseased organ be examined at this stage, its appearance, to the unassisted eye, differs but slightly from that of a gland affected with chronic induration; that is to say, it is hard, condensed, incompressible, and sometimes rather granular on the surface of the section. When the part is examined by the aid of the microscope, the nucleated cells, identical with those found in tumours generally acknowledged to be cancer, are easily seen in the fluid oozing from the tissues. In thin sections of such a diseased breast, these nucleated cells are found to be arranged in small groups, between the fibres or stroma of the organ. This stage of cancer has often deceived superficial observers; for cases of this kind have been recorded in which, after the removal of a tumour not recognised to be cancer, that disease has subsequently developed and killed the patient. The entire gland, or a single lobe, may be thus infiltrated. After the lapse of time, the diseased tissues lose their identity, and they become harder, compact, and of a uniform greyish tint. They no longer maintain any resemblance to the section of a mammary gland, although, perhaps, a few ducts may be indistinctly traced. The next marked change is that which is chiefly characterised by the contraction of the growth. The tumour is now as hard

as a stone. It may be crushed by pressure, scarcely torn. The surrounding textures, not those of the breast only, are drawn towards it, for it seems to have formed a sort of nucleus or centre, dragging all the neighbouring parts together. Upon the cut surface of such a tumour the remains of the ducts are often traceable, forming a finely reticulated figure. This is carcinoma scirrhosum, or the scirrhus cancer, or stone cancer of old writers and the public; carcinoma fibrosum of more recent authors.

The changes before described, which take place in the infiltrating variety of cancer, may often be observed in the different masses of the same gland after its removal. Thus in one part where the tumour has existed the longest time, and over which the integuments are dimpled or puckered, the gland-structure will be found to be entirely destroyed, and just a trace of ducts perceptible. In this part the active growth of the disease would appear to have become arrested, its progress terminated. We often meet with cases in which the entire gland, having been at one time so infiltrated (in which case the disease usually commences in the centre of the organ), subsides into a mere hard nodule, and gives little trouble, if any at all. In another part, the gland-tissue has lost its characteristic features. The ducts are traceable into it, however, and it may still retain an indistinct lobulation. All the interstitial fat has disappeared. The disease has here been growing a comparatively short time, and in sections of such a tumour the elementary structures of carcinoma are well seen. At another part, the section of the gland-tissue appears to be merely indurated, its lobulation is marked, and small lobules of fat are still interspersed. The condition of this portion is the result of quite a recent change. It is due to the earliest stage of infiltration, and the elements of cancer-growths exist there. Thus these three stages of infiltrating carcinoma may be clearly demonstrated in different regions of the same breast, as well as in three separate glands removed from three distinct individuals. We have not space to give here a description of the minute anatomy of these growths at the three stages above described; but it should be stated that their elementary structures, invisible without the aid of a microscope, are quite as characteristic as the appearances to the ordinary vision.

The tuberos variety of carcinoma forms a distinct tuber or circumscribed mass in the breast, quite within its fascial envelope. Its synonyms are numerous. Thus, if soft and brain-like, C. medullare or cerebriform; if firm and solid, solanoid; if jelly-like, gelatiniform; when black, it is called melanic or melanosis. Having ulcerated through the integuments, it is called fungoid; and if profuse hæmorrhage supervene, the term fungus hæmatodes has been employed to mark the fact. But the single feature which most distinctly characterises this form of carcinoma is its isolation from the gland-tissues by means of a more or less well-defined membranous capsule. Thus the tissues of the breast itself are pushed aside by the encroachment of the new growth, and, as they are not at first absorbed, the dimensions of the affected organ, in comparison with the healthy one, accord with the progressively increasing development of new tissue. Contraction, a feature so characteristic of infiltrating cancer, does not occur in this variety. Therefore the progress of tuberos cancer more or less rapidly advances, in the majority of cases, to the formation of a tumour of considerable dimensions. Distinct and separate nuclei of tubers are occasionally developed in different parts of the same breast. By degrees they coalesce, and form one large growth. Again, the tissues of a single tuber will occasionally burst through their envelope, as it were, and form a very large lobulated mass, which separates the breast into several divisions.

The cystiform variety of carcinoma, or a growth of cancer-tissue associated with a collection of fluid circumscribed by a fibrous capsule or cyst, scarcely possesses sufficient individuality to allow of its admission as a distinct *species*, though its *form* is distinct. The solid growth belongs usually to the tuberos form, and the collection of fluid which always bathes a larger or smaller portion of its surface is really but an accidental formation. In morbid structures of this nature, the cyst seems to have attracted the notice of anatomists in a more marked degree than the solid growth. Thus we continually meet with the expression, 'the growth from the cyst-wall,'

whereas, when cases of this description are watched during the growth of the disease, the collection of fluid is often progressively formed upon the surface of a solid tumour. In such a case, the cyst which circumscribes the fluid is a secondary formation, and the solid growth was the cause of its development in the following manner. All surgeons must have observed the quantity of serous fluid poured out from tubers of cancer over which the integuments have ulcerated. This serum flows away, in the absence of anything to allow of its accumulation. But let the fluid ooze from a growth of cancer surrounded by a fibrous envelope, and it will collect, when in excess, between the envelope and the growth, and, separating the capsule further and further, a larger and larger cyst will be developed. Now, if such a tumour be removed, and the walls of the cyst cut open opposite to the growth, the membranous structure falls collapsed, and a solid substance seems to bud forth from its tissues. But make such a single section of the tumour as shall divide the capsule and growth into symmetrical halves, then the relations of the solid growth to the envelope of the fluid will be visible. The observer will notice that he has before him the section of a solid growth of cancer, limited by a more or less distinct membrane, and united with the surrounding tissues of the breast. The 'cyst' will now appear in a different relation. It may be traced in continuation with the fibrous envelope of the tumour, which is, however, more delicate than it, but clearly identical. The surface of the growth, bathed in the serum, has not this envelope; for it has been separated from it by the continual oozing which has taken place, at the same time becoming thicker. Thus the only peculiarity possessed by such a growth of cancer is the addition to some part of its surface of an accumulation of serum in a fibrous capsule. The serum is generally deeply tinged of a brown tint. It is often quite clear. After standing a few hours in a test tube, blood-discs are precipitated. Heat, or nitric acid, being applied, more or less turbidity or coagulation takes place. After the serum has been removed through a cannula, it generally rapidly collects again. This variety of cancer long ago attracted the attention of surgeons, and several writers have alluded to such cases under the title of 'bloody cysts in cancerous breasts.'

Age when carcinoma is most commonly developed.—The fifth decade of life is that in which carcinoma is most frequently developed in the breast; that is, from the fortieth to the fiftieth year. Before twenty years of age the writer has never seen a case.¹

The table below shows the proportion of cases at various ages. Most of the cases were under the observation of the writer; they have not been in any way selected by him, and great care was taken to note the age at which the disease was first observed:—

Age from 20 to	30 years	.	.	.	.	.	.	.	19
" 30 "	40 "	.	.	.	.	.	.	.	100
" 40 "	50 "	.	.	.	.	.	.	.	193
" 50 "	60 "	.	.	.	.	.	.	.	97
" 60 "	70 "	.	.	.	.	.	.	.	34
" 70 "	80 "	.	.	.	.	.	.	.	6
" 80 "	90 "	.	.	.	.	.	.	.	7
" 90 "	100 "	.	.	.	.	.	.	.	2
									458

Even taking into calculation the disproportion of individuals alive at any definite periods, the numerical proportion here given shows that an excess of cases belongs to the fifth decade; for only thirty-six less than half the total number appear in those ten years, or rather more than two-fifths against all the cases at other ages.

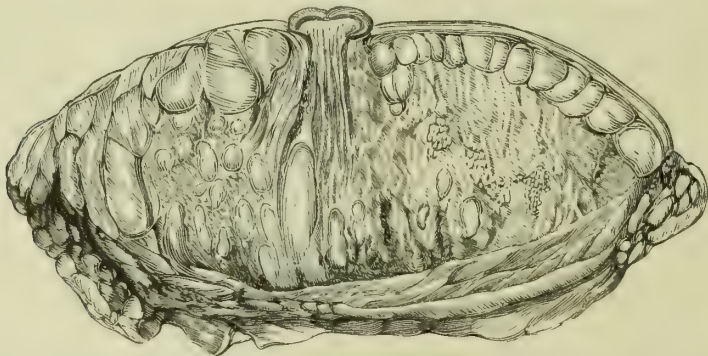
The constitutional nutrition of persons afflicted with carcinoma varies, at the development of the disease, between the appearances of robust health and general cachexia. In some cases late in its progress, or even in the last stages, its ravages upon the general health are not very apparent. Some writers assert that, if careful

¹ Mr. Lyford (*Lancet*, vol. xii. p. 332) and Mr. B. B. Cooper (*Lectures on Surgery*, 8vo. 1851) each record a case; the former at eight years of age, the latter at thirteen. In the Museum of St. Bartholomew's Hospital, the Preparation ser. xxxiv. 4, was removed from a girl aged sixteen years.

inquiries be made, it will be in most cases ascertained that the state of the general health has been below the average healthy standard for some time previous to the discovery of the disease. But, after the most careful researches in reference to this most important point, the writer has been unable to arrive at any definite results. The statement may certainly be made, without fear of contradiction, that all circumstances tending to depress the vital powers are very commonly associated with the development of cancer. Thus severe mental distress, losses of blood, poverty, intemperance, are commonly marked features in the history of the lives of individuals afflicted with this disease. Still, who would be bold enough to assert, after much experience of the vicissitudes of social life, or of the habits of the people, that these are predisposing causes to its development? Surely, if they were, the disease would be even much more common than it is.

To the cessation of the catamenial function it is usual to refer some baneful influence, and thus to associate cancer with this natural result. But, after careful inquiry, it is found that, of any given number of cases, in a large majority of the women the function is persistent at the moment of the development of the disease. Thus, abstracting this fact from a hundred cases, not selected, but as they chanced to come under observation, we found that the catamenia were persistent in 70, and that the function had ceased in 30 only. Again, the table of various ages on the previous

FIG. 97.



Progressive infiltration of the whole gland is represented in the woodcut, with the infiltration extending between the ducts, and by their side to the integuments. The nipple is not retracted because infiltrated. (From a drawing in the Museum at Guy's Hospital, No. 413³⁶.)

page shows that the largest number of cases occur between thirty and fifty years, during which period this function is active, admitting its cessation about the forty-fifth year as an average.

Unmarried women are said to be more prone to cancer of the breast than the married, and sterile women rather than prolific. The following facts, derived from an examination of a hundred cases, prove the fallacy of such assertions. Thus, of 100 females suffering with cancer, 86 were married, 14 were single. Of the 86 married women 73, were prolific, 4 had aborted, and 9 were sterile. As regards lactation, the writer has failed in establishing any marked relation between the imperfect performance of this function and the subsequent development of cancer. It is a notable fact, especially in relation to diagnosis, that cancer is very rarely developed during pregnancy or suckling.

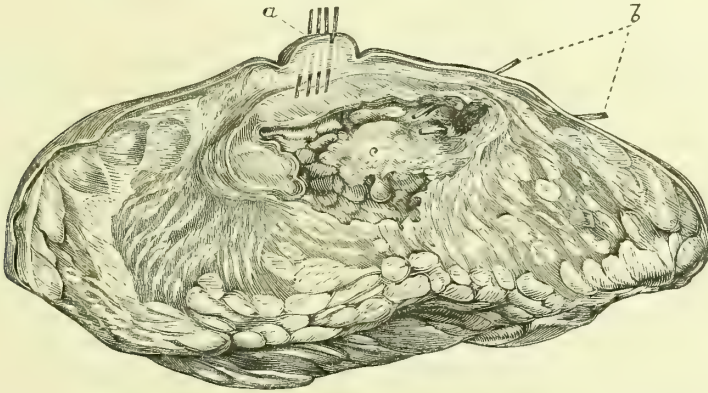
The primary development is usually observed in the substance of the breast, upon its surface or at its periphery. The patient very frequently accidentally discovers the hardness first by the touch, neither pain nor uneasiness in the part having been experienced. When the growth is seated at the margins of the gland, or upon its surface, it is frequently very movable, circumscribed, and distinct. If, however, lobular infiltration exists, the tumour seems to form an integral portion of the breast, and its isolation from the surrounding structures is impracticable. Diseased gland-tissue and healthy seem to be inseparably blended together. Often, if the infiltration involves the central portion of the breast, the whole organ feels merely indurated

and is perhaps unaltered in shape. At this early stage there is usually very slight change in form. Unless the patient be very thin, there is no visible sign of the tumour. We assume, at this time, that its dimensions do not exceed two inches in diameter. The progress of the infiltrating variety of the disease may be wholly confined to the breast throughout the remainder of the life of the patient. In such a case the gland-tissue having been destroyed by the new growth, contraction takes place; and the disease, where first observed, subsides into a mere rigid inert mass.

If the growth be of the tuberos variety, a circumscribed swelling is discovered in the breast, which at first increases slowly. But here there is always a visible sign of something new being superadded to the bulk of the gland, so that in proportion to the size of the growth the affected breast is just so much in excess of the dimensions of the sound one. This marked disproportion in the comparative sizes of the two glands, in relation to the quantity of new growth in the one diseased, is much more noticeable in tuberos cancer than in infiltrating. In the early stage, too, the pain in the part is more marked.

Occasionally, at the commencement of the disease, the truly infiltrating form may occur, and during its progress pass into the tuberos. But we do not meet with the opposite condition, at least as regards the gland-tissue. It frequently happens that, during the growth of a tumour or circumscribed mass of cancer, a cyst is formed

FIG. 98.



The woodcut shows a section of a growth of this kind, which, softening down in the centre, leaves a hollow. The borders of the growth are seen, and pieces of glass (*b*) passed through the sinuses or fistulae in the skin communicating with the cavity (*c*). (*a*) Nipple and ducts with bristles introduced. (From a drawing in the Museum at Guy's Hospital.)

upon its surface. At least, a collection of serous fluid and blood, in relation with the growth, is frequently designated a cyst. In such a case the fluctuation of the fluid is usually distinct. Another change results from the centre of the new growth softening. Whether this process arises from inflammation or the immediate death of the tissues, we cannot here discuss; but the fact is important on account of the alteration it produces in the palpable signs of the tumour. After feeling solid, perhaps rather elastic, fluctuation is detected, and the surgeon hopes the case may prove to be one of chronic abscess. Even the visible signs which subsequently arise may favour the delusion; for the skin, becoming thin and red, *almost* assumes the ordinary appearance of the 'pointing' of pus. The integuments ulcerate slowly. Several openings sometimes form consecutively. But the discharge is never genuine pus. It is curdy or flaky, blood-tinged; it emits a foetid, perhaps an offensive odour, and a healthy process is not excited. At last, the tumour being removed, a section through its centre shows the new growth, with the cavity in its interior; the walls of the hollow being formed of cancer-tissue, usually varying from a quarter of an inch to three-quarters in thickness. The fistulous openings in the skin lead to sinuses communicating with the interior of this growth.

As a rare form of the disease, we must mention that one in which innumerable

tubercles are disseminated throughout the substance of the gland; and which, by slowly growing, form larger and larger tubers, until they coalesce into a single mass.

Hitherto we have only described the development of cancer in relation to the breast. But in the progress of the disease all the surrounding structures become involved. Hence there are certain stages of this fearful malady which it is absolutely necessary to describe briefly before alluding to its treatment.

In both kinds of carcinoma, infiltrating and tuberos, the integuments become involved in the disease, but in very different conditions and degrees. In the former, the fat between the gland and the skin becomes absorbed, and the new growth extends along the fibrous septa, infiltrating those structures; and when it has reached the skin, it spreads in that envelope far and wide. The adhesion between the skin and the anterior surface of the breast is very clearly indicated by dimpling or puckering of the integuments over the tumour, and the loss of the natural freedom of movement of the skin upon the gland. Very superficial ulceration next takes place in that part of the skin which has been for some time of a dull red or purplish tint. The ulceration extends deeper and deeper, wider and wider, sometimes leaving a large portion of the breast in a healthy state, whilst it creeps onwards in the surrounding integuments only. Occasionally with merely redness of the skin, sometimes even with scarcely a blush, and in rare cases with an absence of red altogether, the infiltration of the integuments advances, contraction of the infiltrated tissues takes place, and the whole surface of one side of the chest or of both sides is encased in a horny, rigid, unyielding envelope, which entails most acute suffering. Such is the cancer *en cuirasse* of the French writers.

In another case, after the skin has become once infiltrated, minute and isolated centres of cancer spring up in the neighbouring integuments, and as they grow, the skin ulcerates, and several detached cutaneous ulcers are developed.

The tuberos variety increases with more or less rapidity, elevating the skin, which becomes thin, its vessels congested, and therefore often of a brilliant hue, shining, and tense. This appearance sometimes closely resembles that of a pointing abscess; but it may be distinguished from it by its slow progress, the little pain accompanying the disease, a more sharply circumscribed redness, and the absence of that gently varying shade of tint from the centre to the periphery of the coloured surface so characteristic of inflammation. As regards, however, intensity of colour, there is no disease which in this respect at all approaches the brilliant red of some varieties of tubers of carcinoma developed in the skin. The progress of this variety differs remarkably in different cases. The changes which occur are chiefly due either to morbid processes taking place in the new growth, and destroying it, or to the vitality of the growth being maintained when the disease progresses. Thus, two most opposite conditions result. In one, after the integuments have ulcerated, nearly the whole growth sloughs out; in the other, the tumour continues to grow, and a large fungating mass is formed, which reaches prodigious dimensions in some cases. Accompanying this fungous cancer there is generally a profuse serous secretion, sometimes almost clear, but emitting a sickening nauseating odour; at other times a sanious purulent discharge, mixed with the débris of the growth, the effluvium from which is intolerably offensive. Profuse hæmorrhages commonly take place from such growths, from which circumstance William Hey attempted to establish a special variety of cancer.

The above remarks apply to the most common varieties of cancer affecting the breast. Varieties both in appearance, mode of increase, rapidity and slowness of growth, from infiltration of neighbouring tissues, and from accumulations of serum and blood enclosed in cysts, often occur; into a description of which the limits assigned to this essay do not permit us to enter.

Retraction of the nipple occurs in the infiltrating variety of carcinoma; it does not in the tuberos. It is always most marked when the infiltration is central; and sometimes the nipple may be drawn in and towards the hardness when lobular infiltration only exists. This state of the nipple then is pathognomonic only of the variety of the disease, and of the stage at which it has arrived. It should never be regarded as

conclusive evidence of the nature of the disease, but merely as an accidental occurrence.

The nipple sometimes projects considerably after having been deeply retracted. That organ is then infiltrated with carcinoma. When thus diseased, the section, as represented in the woodcut, shows a remarkable prominence of the nipple.

The lymphatic glands in the axilla, above the clavicle, and even those at the side of the neck, become infiltrated with cancer as the disease advances. Usually, however, the growth in the breast has been observed some months before they are affected, and generally the integuments are more or less implicated before they are deeply involved. Sometimes the disease, first noticed in the breast, seems to remain quiescent, and the axillary growth advances rapidly. As the morbid condition of the axillary glands advances, the upper extremity becomes œdematous, serous effusion into the pleura of the same side takes place, and the sufferer dies without the primary local disease causing much trouble.

The causes of cancer, hereditary influence, if there be any, relating to its generation, points belonging to the natural history of the disease, are described in the essay on TUMOURS.

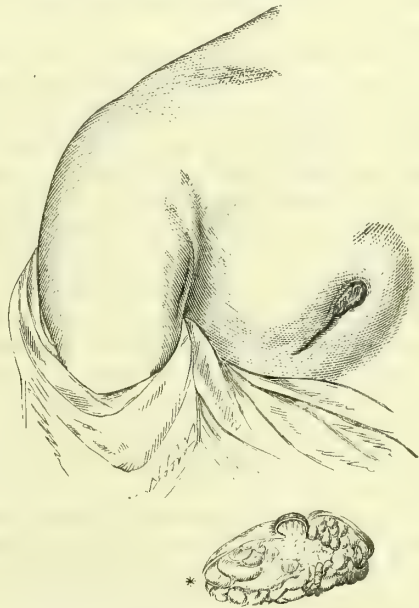
The treatment of cancer of the breast may be carried out upon two principles. The surgeon has therefore to decide whether the growth shall be allowed to pursue its course under a palliative plan of treatment, or whether the tumour and diseased organ shall be taken off from the body by a cutting operation, or some other method.

There are those who refuse to admit the efficacy of removing a growth of cancer under any circumstances, and there are others who would take it away in every case. A surgeon who would adopt either the one proceeding or the other exclusively must, we think, err in the treatment of this class of cases. The fact is, we believe, that, in a great number of persons, life may be prolonged, local suffering may be prevented, and much mental anxiety is sure to be avoided, by a careful and judicious selection of those cases in which the removal of the primary growth can be easily effected, and in which the constitutional powers of the patient render a surgical operation admissible.

We may here add, in a very few words, that in every case of the kind the state of the patient's general health is of primary importance. If that be impaired, the doubtful issue of an operation would deter most surgeons from recommending a proceeding under the influence of which the sufferer might sink; but when, as often happens, the constitution seems to be unaffected, surely that which the surgeon knows to be a sign, a source, an origin of impending misery, may be taken away with a fair hope of advantage. In order to point out the cases in which the removal of the cancer is neither desirable nor admissible, we may refer the reader to the lecture of Sir Benjamin Brodie,¹ and to the essay on TUMOURS.

We consider the operation of removing the tumour, together with the breast, always admissible when the health of the patient appears to be favourable to recovery from that operation, when the disease involves the tissues of the breast only, and when the axillary lymphatic glands are not involved.

FIG. 99.—Infiltrating Carcinoma of the Breast and Nipple.



The uppermost figure shows a projecting nipple though apparently embedded in the adjacent tissues. The section shows a mass of carcinoma surrounded by fat, and the outgrowing nipple also infiltrated. Patient, aged forty-five, growth one year. (Drawing in Guy's Hospital Museum, 4091^o.)

¹ *Lectures on Various Subjects in Pathology and Surgery.*

We believe it may be undertaken with advantage when the disease has extended to the skin without infiltrating the cutaneous tissue to a wide extent, when ulceration has taken place, and even when the axillary lymphatic glands are distinctly perceptible and somewhat enlarged. As a general rule, it may be stated that the more limited the local disease is at the time of the operation, the better the chance of a satisfactory result as regards the region, and that if the general health of the patient be well attended to, after the wound has healed, some prospect appears of considerably ameliorating the condition of a sufferer affected by this disease.

We cannot here discuss the advantages or disadvantages of a cutting operation, as compared with the removal of the tumour by other methods. Both means have their advocates; both plans may be adopted in special cases. The one is expeditious, attended with little suffering, certain of removing the whole of the diseased organ. The treatment by caustics is tedious, attended generally with excruciating pain, and very uncertain in its operation.

In comparing the results of the two methods upon the constitutional progress or local relapse of the disease, there is not sufficient evidence in favour of one over the other. Both are commonly followed by a development of cancer either in the region first affected and its vicinity, or new centres of growth become established in distant parts.

The treatment of ulcerated cancer consists in following out the principles applicable to all sloughing open surfaces; thus, all those applications which tend to cleanse the surface are especially serviceable. Lotions composed of solutions of the chloride of zinc, permanganate of potash, terchloride of carbon, or chloride of potash, are very useful; with which sedatives, as morphia, solutions of opium, or belladonna, may be combined to soothe the pain. Some substances, applied in the form of powder, as equal parts of chloride of zinc and oxide of zinc, or the former mixed with some farinaceous powder or gum, serve very well to induce a more rapid sloughing of the new growth, and a more tolerable state of the ulcerated surface. By persisting in these applications, the wound occasionally even closes, and a tolerably healthy cicatrization of the normal tissues is the result.

The hæmorrhages attending these ulcerated and sloughing surfaces may be controlled by cold, by the application of astringent powders or lotions, and other common styptics. When practicable, the slough from under which the bleeding usually takes place should be removed, in order that the styptic may reach the open vessel.

The œdematous condition of the tissues of the upper extremity which in some cases arises upon infiltration of the axillary lymphatic glands, is a source of great suffering, which it is very difficult to ameliorate. Local means generally avail little. The elevation of the arm assists the return of the serum, and subcutaneous punctures are beneficial.

When a second, a third, or even a fourth or more growths appear, their removal is quite justifiable, provided the constitutional powers of the patient be good, and the local disorder threatens to become a source of prolonged misery and suffering.

The mortality depending upon causes referable to the operation of amputation of the breast is extremely small: the proportion in cases treated in Guy's Hospital being about six per cent.; whilst in private practice it has not amounted to anything like that figure.

The limits of this essay preclude even touching upon the many points of great interest in the natural history of cancer; but the reader may supply the deficiency by turning to that on TUMOURS, in which the whole subject of the disease is fully treated of. But I cannot conclude without urging the expediency of removing the *first* growth of cancer in *select* cases. I do so upon the firm conviction, based upon experience, that by so acting life may be prolonged; a certain amount of immunity from bodily suffering and mental distress may be insured; the chance of freedom from all local suffering is given; and that, when unhappily the recurrence of the disease gives rise to ulceration, the duration of that distressing state is shortened.

SPECIAL DISEASES. DIVISION IV.

Diseases of the Nipple and Areola; the Sinuses; the Sebaceous Glands.

Deficiency of the nipple.—This deformity results from an arrest of its development, or is produced by disease. When, however, a breast exists, there is always a trace of a nipple and areola. There may not be the slightest elevation; even a depression may occupy the site of the mammilla; but the milk-tubes terminate between the rugæ on a small spot of skin. The nipple is often destroyed by disease. Thus gangrene occasionally attacks it, and the whole organ falls off. Also, a nipple once well formed may be drawn inwards or retracted, and so deeply that its extremity is entirely lost to view. But in every case in which a surgeon observes this condition, especially if associated with disease, he should be scrupulously careful to ascertain if the deformed organ was ever perfectly developed.

A bifid nipple is sometimes seen; and occasionally it is ill-shaped, being clavate, pendulous, and covered with small tubercles. Hypertrophy of its tissues occurs but rarely. There are cases on record in which several nipples have been developed on one breast (*pleiomastia*).

Inflammation often attacks the nipple. It is especially prone to this condition during the first occasion of suckling, and with some women at the commencement of every lactation. The most frequent result of that morbid condition is the production of superficial ulceration upon its surface. Small ulcers are formed between the rugæ, on its apex and sides, and sometimes they encircle its base, even extending upon the areola. The abraded surfaces are exquisitely painful, and they often bleed freely. Much constitutional disturbance, mental distress, and acute local suffering are excited by these superficial ulcers, which are commonly termed ‘cracks,’ ‘fissures,’ or ‘chaps.’ It is asserted that these ulcers are frequently engendered by the morbid state of the mucous membrane of the infant’s mouth. We have not, however, been able to obtain sufficient evidence of the validity of the statement. As regards treatment: the most essential point towards remedying these troubles consists in frequent ablutions with warm water, in abstaining from the application of irritating lotions and ointments, but protecting the part with moist cotton-wool and gutta-percha tissue. A difficulty in most cases arises from the necessity of suckling the infant. Various ‘shields’ are constructed, therefore, to protect the organ from the pressure and dragging caused by the lips and tongue of the infant. The application of soothing substances is preferable to those which produce pain, and therefore a little glycerine, collodion, or almond-oil is beneficial. Astringent, stimulating, and narcotic applications are not always admissible, on account of the suffering they entail upon the mother, and the risk of injuring the infant. Substances in dry impalpable powder are beneficial. Thus, the oxide of zinc, carbonate of magnesia, lycopodium, prepared chalk, may be tied up in very fine muslin, and the nipple dusted with the particles which pass between the threads. Abscesses, sloughing, herpetic or eczematous eruptions and syphilitic ulcers affecting the nipple, require suitable treatment.

Hyperæsthesia of the nipple.—We have seen a curious condition of the nipple, but only once, to which the term hyperæsthesia seems the most applicable. The organ became, upon exposure, rigid, its follicles very distinct, its base red, and its point bloodless, and hence quite white. It was on the person of a middle-aged, married, but sterile woman, who described the pain as most acute.

Inflammation and abscesses, together with various cutaneous eruptions, are developed in the tissues of the areola. Abscess often forms in the portion of the gland immediately beneath it. The point of chief importance to remember in connection therewith, is, that the lacteal sinuses are placed here, and that great care is requisite to avoid cutting them transversely if a bistoury is required to be used. It is always desirable to allow pus to point very prominently when it is formed beneath the areola; and if an incision be made, its direction should always pursue a straight line radiating from the nipple. The effect of departure from these directions may be the

division of a duct ; the consequence of which will be that, a fistulous opening being established, the milk will flow freely every time the woman suckles, for it rarely heals until after weaning.

Within the area of the nipple and areola new growths are occasionally developed. Pendulous, cutaneous formations ; follicular tumours, or cysts, containing sebaceous secretion ; vascular growths of true erectile tissue ; epithelioma, and infiltrating carcinoma, have all been met with in various degrees of frequency ; but as they require to be treated upon the same principles as when found in other parts, it would be idle to dwell upon them here.

SPECIAL DISEASES. DIVISION V.

Diseases of the Male Mammilla.

The affections of the male organ relate to its conditions in a perfectly rudimentary state, and when there is a gland developed ; for we have seen and dissected as perfect a passive glandular structure taken from a man as was ever formed in a young girl. Soon after birth the organ becomes tumid, and a secretion forms within the ducts. If left to nature, no difficulty arises. Should inflammation happen, which usually arises from the officiousness of nurses, it must be treated as before described.

At puberty the gland usually enlarges, becomes painful for a few days, and then slowly decreases until nothing but the nipple is perceptible. But if the part be irritated, inflammation running on to the formation of abscess will be excited. In rather delicate men the gland is sometimes largely developed—hypertrophy. This may occur on one side only, or on both sides. The circumstance generally excites annoyance, but no ill result ; although the curious may see in pathological museums breasts of this kind which have been removed and labelled ‘scirrhus.’ When these breasts are painful, the improvement of the general health is indicated, and all local pressure must be avoided.

The male is subject to deformities arising from excess of mammillæ ; thus we have seen a man with four nipples. We have met with a man who had one only, on the right side. The defect was associated with absence of the lowermost fibres of the left pectoral muscle.

The diseases of this organ in the male are of the same kind as those in the female, already described. But disease very rarely attacks this part in a man. We have seen a sebaceous cyst developed close to the nipple and elevating it, and so closely resembling the bluish-red tint of a tuber of cancer just about to ulcerate as to excite grave apprehension ; but it was excised with the happiest result. Mr. Prescott Hewett¹ removed a cyst and intra-cystic growth from a man’s breast.

Carcinoma is the new growth most commonly developed in the male breast. It occurs generally between forty and fifty years of age, either in the infiltrating or tuberos form ; generally, however, in the former, extending slowly, and affecting the integuments in its progress. Its treatment is similar to that adopted in the case of a like disease in the female.

JOHN BIRKETT.

¹ *Lancet*, vol. i, 1864.

DISEASES OF THE MALE ORGANS OF GENERATION.

FAILURES IN DEVELOPMENT OF THE TESTICLE.

THERE are two peculiarities in the development of the testicle which deserve notice here, forasmuch as they are related to certain peculiarities in the pathology of the organ. *First*, each testicle is formed from two distinct parts. The *body* of the gland is produced from primitive fœtal structure in front of, but apparently independent of, the Wolffian body, or temporary kidney, which lies along the hinder wall of the abdomen; whereas the *epididymis* is evolved from the upper part of the Wolffian duct, the vas deferens being the continuation of the lower part. Reminiscences of this mode of development are furnished by the vessels which supply the two parts. The spermatic artery, derived from the aorta a little below the renal arteries, is distributed chiefly to the body of the testicle; and the deferential artery, from the superior vesical, is distributed to the vas deferens and part of the epididymis, the remainder of the epididymis being supplied by the anastomosing branch between the spermatic and the deferential arteries. The close sympathy also of the epididymis with the several parts of the urinary apparatus, particularly with the prostatic part, evinced in the frequent excitation of inflammation in it by irritation in the urethra, bladder, or kidney, and the manner in which that inflammation is commonly confined to it, without spreading to the body of the testicle, are probably, in some measure, due to the mode of development of the organ.

The *second* peculiarity is the change of position from the lumbar region to the scrotum, which takes place gradually during the fœtal state, and is usually accomplished before birth. The physiological purpose of this change of position, and the means by which it is effected, are not quite clear. Viewing it in a pathological light, we feel that had the testicle been retained in the abdomen, and possessed the same sympathies and liabilities to disease which it now has, it would have proved a troublesome companion to the other viscera. At the same time it would have been less exposed to injury, and the many maladies consequent upon its passage through the abdominal wall would have been spared. We must not forget that the covering of peritonæum which it acquires in its course is a considerable protection against injury, from the facility with which it enables the testis to glide away from pressure,¹ and also from its preventing the extension of disease inwards to the testis, as is seen when inflammation is limited to the epididymis by the 'digital pouch,' that process of visceral tunica vaginalis which runs in deeply between the outer surface of the testis and the epididymis.² Prof. Cleland³ considers that the object of the descent of the testis is to be sought for on functional and not morphological grounds. Thus its pendent position, its very complicated structure, its very dense capsule, the contractile structures which surround it—these peculiarities, together with the remarkable points about the vessels of the testis, are all correlated with the peculiarity of the secretion, its complexity, its elaboration and gradual removal. Thus the tortuosity and peripheral increase in diameter of the artery, the abundance, tendency to varicosity, and imperfect valves of the veins, all tend to render the circulation

¹ Another provision with the same view is seen in the fact that one testis, usually the left, hangs at a lower level than the other. By this arrangement one testis slips readily under the other, and so escapes any damage, as in the frequent movements of approximation or crossing of the thighs.

² See below, p. 478.

³ *Mechanism of the Gubernaculum testis*, App. pp. 35 *et seq.*

slower, and to bring about accumulation at the most dependent part, so that the testis will be kept in a slowly moving bath of blood. Now the dense nature of the tunica albuginea admits only a certain amount of blood at a time, so that when the tubules are empty the blood-vessels will be distended, and thus the gland will be most favourably situated for secretion. On the other hand, as the tubules fill, the blood will be forced out, and thus matters will be disposed in the manner best fitted to promote absorption of any excess of secretion.

Supernumerary testicles.—These may be dismissed with the statement that there is no clear evidence of one having ever been met with. The supposed additional testicle has in each case, when it has been submitted to dissection or to careful examination, been proved to be either an encysted hydrocele,¹ or a fatty or fibrous tumour² in the cord or in some part of the scrotum, or a piece of omentum.³ In the verification of these conditions the absence of testicular sensation is the best guide.

Absence of one or both testicles. Monorchism. Anorchism.—These conditions, especially the latter, are extremely rare.⁴ It is not to be confounded with cryptorchism, or retention of the testis in the abdomen, from which, however, it is only to be really distinguished by dissection. Dr. Gruber, of St. Petersburg,⁵ concludes that unilateral anorchism occurs in subjects otherwise well formed, and that it is rarely associated with malformation or deficiency of internal viscera. The subjects of bilateral anorchism, on the other hand, frequently present malformations of the penis, and also of various external and internal organs; they are usually men of feeble body, and rarely reach advanced age. In cases of unilateral anorchism the left side is the one more frequently affected.⁶ A few well-authenticated cases are alluded to below, in which one or both testicles have been entirely absent.⁷

Another condition which may be mistaken, at first sight, for congenital deficiency of one or both testes is extreme fatty degeneration and atrophy. Here the presence or absence of any trace of tunica albuginea, or of vas deferens (though this latter may have been converted into a mere fibrous cord), will help in deciding the question.

Absence or deficiency of the vas deferens.—These, though rare, are more common

¹ In a patient who presented himself in the out-patient room at Guy's Hospital as 'the man with three testicles,' the third testicle was found to be an encysted hydrocele, and disappeared on tapping. A similar case is recorded by Mr. Curling, *Dis. of the Testis*, 3rd ed. p. 3.

² In the Museum of St. Thomas's Hospital is preserved a specimen which shows that the body supposed during life to have been a third testicle is really a fibrous tumour attached to the tunica vaginalis.

³ Morgagni (*Seats and Causes of Diseases*, vol. ii. 'Dis. of the Belly,' p. 545) records the following:—'In a man who seemed when living to have three testicles, the testes were only two; what seemed to be the third was a portion of omentum which had descended into the scrotum, wrapped up in its proper sacculus of peritonæum. The portion of omentum which in the living body had resembled a testicle must be added to the other instances which may impose upon us in like manner, and which formerly created a suspicion in me (Advers. 4, Animad. 1) on reading such a number of observations of three testicles taken notice of by De Graaf and others, that there was some deception in many which were not confirmed by dissection after death.' Cases of supernumerary testicle are recorded in the *Lancet*, 1865, vol. ii. pp. 448, 473, 501. There was, however, no proof beyond that of external examination in any of the cases. So, too, with Flögel, *Ueberzählige Hoden. Oesterr. Zeitsch. f. prakt. Heilk.* 39, 1858. In two cases of double penis (Van Buren, *Surg. Dis. of the Genito-Urin. Organs*, p. 4) the testes were normal in number.

⁴ So too with the ovaries. These are hardly ever absent unless this defect is associated with absence of the uterus, and often with ill-developed genitals and breasts. More commonly the ovaries are well developed, when the uterus is absent.

⁵ *Oesterr. Med. Jahrb.* No. 1; and Canstatt's *Jahresbericht*, 1868.

⁶ In some cases of unilateral anorchism hypertrophy of the opposite testicle has been present. Thus, in one case, recorded by Mr. Curling, of entire absence of the left testis, that on the right side weighed two ounces and a quarter (*loc. supra cit.* pp. 5-59.)

⁷ Mr. Thurnam, *Med. Gaz.* August 1837. Sir J. Paget, *Med. Gaz.* vol. xxix. p. 817. Dr. Fisher, *Am. Journ. Med. Sci.* vol. xxiii. p. 352. MM. Le Gendre and Bastien, *Gaz. Méd. de Paris*, 1860, p. 217. Godard, *Gaz. Méd.* 1860, p. 435. *Recherches sur les Monorchidies et les Cryptorchidies chez l'homme*, Paris, 1856. *Études sur la Monorchidie et la Cryptorchidie chez l'homme*, 1851. *Mémoires de la Société de Biologie*, 1856, p. 216; 1857, p. 382; 1859, vol. i. p. 341 and p. 327.

than the absence of the testis. The vas deferens may be deficient at either end,¹ or through nearly its whole extent.² Lastly, in one or two cases the vas deferens has been found closed at both ends.³ With these imperfections of the vas deferens absence of the testes⁴ may also be present; but more commonly the testes and vesiculæ seminales are of normal size. Experimental observations⁵ have also shown that while ligature of the spermatic artery and vein causes sloughing or atrophy of the testis, division or ligature of the vas deferens has no such effect.

From the above remarks it will be seen that both testes and vesiculæ seminales may be well formed, and may continue to be well nourished though entirely useless, from the want of vas deferens to connect the one with the other; so that the plumpness of a testicle and its descent into the scrotum are no certain indications of the performance of its function being possible.

Furthermore, as long as the testes exist, entire though useless, all the usual marks of the male sex are preserved.

Sir J. Paget⁶ has explained these deficiencies in the vas deferens by reference to the development of the sexual organs. These are normally developed in two distinct pieces. Thus the testis or ovary is formed on the inner surface of the Wolffian body, and the seminal or ovi-duct, originally an isolated tube closed at both ends, passes along the outer border of the Wolffian body from the testis or ovary above to the cloaca or common sinus of the urino-genital and digestive organs below. The sexual character is first established when in the male, the formative and conducting organs become connected by the development of intermediate tubes, which constitute the epididymis. The fact that in some cases it is duly developed in a very small part of its extent, and that in others it fails to acquire its due connection with the testicle or bladder, proves that the testes are developed independently of the vas deferens.

INCOMPLETE OR ABNORMAL DESCENT OF THE TESTIS. MALPOSITION OF THE TESTIS.

These abnormalities, being more common, are of much greater practical importance than the preceding. Of 103 male infants examined at the time of birth by Wrisberg,⁷ seventy-three had both testicles in the scrotum; in twenty-one, one or both were in the groin; the remainder had one or both in the abdomen. The imperfection appears somewhat more commonly on the left side.⁸ In these cases the descent of the testis may be completed within the first few days or weeks of birth. It may also occur later on. Mr. Hunter⁹ held that 'the completion most frequently happens between the years of two and ten, while the person is young and growing, being seldom delayed beyond the age of puberty.' Later still, owing to increased functional activity as adolescence goes on, the testis may be noticed to descend. Thus, Sir A. Cooper¹⁰ has 'many times seen the testes descending from thirteen to seventeen years, probably from new excitement at that period; and the descent is in some cases not accomplished till twenty-one.' Under these circumstances the testicle is liable to be accompanied or followed by a portion of intestine, forming a 'congenital hernia,' and not unfrequently the bowel is adherent to the gland. With reference to this most important point Mr. Curling¹¹ states that his own observations lead him to believe that if the descent does not take place within a twelvemonth after birth, it is rarely completed afterwards without being accompanied by rupture.

Varieties of malposition of the testis from its incomplete or abnormal descent.—

¹ Sir J. Paget, *loc. supra cit.* p. 817.

² Gosselin, *Arch. gén. de Méd.* 4^e série, t. xiv. p. 408.

³ Turner, *Edin. Med. Journ.* Jan. 1865.

⁴ Sir J. Paget, *loc. supra cit.* p. 817.

⁵ Mr. Curling, *loc. supra cit.* p. 11 *et seq.* Sir A. Cooper, *On the Testis*, p. 51. M. Gosselin, *Arch. gén. de Méd.* Sept. 1853.

⁶ *Loc. supra cit.* p. 818.

⁷ *Comment. Soc. Reg. Scient. Goett.* 1778.

⁸ M. Godard (*loc. supra cit.* p. 36) found that of thirty-six monorchides, the arrest was on the left side in twenty-two, and on the right in fourteen. On the other hand, Szymanski (*Prager Vierteljahrschr.* 1868) states that the right was the affected organ fifteen times out of twenty cases collected by Ouslatet, and in thirty out of forty-seven by Pétrequin.

⁹ Works, edited by J. F. Palmer, vol. iv. p. 15.

¹⁰ *Obs. on the Struc. and Dis. of the Testis*, p. 44.

¹¹ *Loc. supra cit.* p. 15.

For the sake of convenient description, these may be divided into: (a) Incomplete descent of the testis, or retention of the testis; (b) Abnormal descent of the testis, or ectopia testis.¹

(A) *Incomplete descent of the testis. Retention of testis.*—Instead of reaching the scrotum, the testis may never leave its original home, or after starting it may be arrested at almost any point of its normal course. Thus it may remain on the posterior wall of the abdomen, in relation with the kidney, or float freely in the cavity of the abdomen by means of a mesorchium of varying length, formed by two layers of peritonæum united behind the testis; in this case the very mobility of the testis hinders its entrance into the inguinal canal. The above constitute *retentio abdominalis*. A much more frequent position for the testis is just within the internal abdominal ring (*retentio iliaca*). A good representation of this condition has been given by Mr. Wood.² Finally, the testis may occupy the inguinal canal (*retentio inguinalis*), being in this case most frequently situated near the external abdominal ring (p. 465). When in the canal the testis, especially in early life, possesses very considerable mobility, being readily pressed up into the abdomen, and at once reappearing. Sometimes it is only noticed to occupy the inguinal canal when the patient is in the erect position; but as life goes on, the testis becomes subject to recurrent attacks of inflammation, and thus is more and more fixed. Retention of the testis in the iliac and inguinal regions is much more common than that in the abdomen. Whether either one of the two former conditions is more frequently met with is at present doubtful.³ The distinction, however, between iliac and inguinal retention is an important one, as in the latter case the testis is more likely to become degenerated or functionless, and the cause of peril to the patient.

Causes of retained testis.—These must remain somewhat uncertain until the means by which the normal descent of the testis is effected are fully known. Amongst the best established causes are:—(a) *Intra-uterine peritonitis*.⁴—As a result of this, adhesions may undoubtedly form and impede the descent of the testis. Mr. Curling⁵ has collected several such instances in which adhesions, often multiple, have existed between the testis and the sigmoid flexure, the cæcum, and omentum. One of the best cases of this kind is one reported by Mr. Wood,⁶ in which the left testis of a man aged between forty and fifty was found lying in the left iliac fossa between the sigmoid flexure and the internal abdominal ring. ‘Passing from the globus major to the mesenteric border of the sigmoid flexure were three very distinct transparent bands of adhesion. In many of the mesenteric glands were found chalky concretions like the débris of tubercle.’ Mr. Wood considers that these conditions pointed to ‘local inflammation from mesenteric disease in fetal life or early infancy, formation of adhesions, and arrest of the descent of the gland at the utmost stretch of the adhesive bands.’ This testis was only a third of its proper size, the right, which was in the scrotum, being double the natural size. (β) *Small size or contracted condition of the external abdominal ring.*—Mr. Curling⁷ considers that the fact that the testis is oftener found in this situation than in the cavity of the

¹ M. Follin (*‘Anom. du Testicule,’ Arch. gén. de Méd.* 1851, p. 257) groups the different displacements of the testis under the following heads:—(1) Cases where the testis is retained in the abdomen or in the inguinal canal, its relation with the epididymis and vas deferens being normal, and the scrotum containing cellular tissue; (2) cases where the testis is retained in the abdomen or in the inguinal canal, the epididymis and vas deferens being found to a greater or less extent in the scrotum instead of the testicle; (3) cases where the testis is directed towards the perinæum; (4) cases where the testicle has traversed the crural canal.

² *Path. Soc. Trans.* vol. viii. p. 265, pl. iii. fig. 3. Kocher (*Krankh. d. Hodens.*; Pitha u. Billroth, *Handbk. d. Chir.* Bd. 3, S. 416) figures another instance.

³ Kocher (*loc. supra cit.* p. 414) considers the iliac retention to be the most frequent of all. Mr. Curling (*loc. supra cit.* p. 224), on the other hand, considers that retention is most common close to the external abdominal ring. See also the remarks of Prof. Richet quoted at p. 465.

⁴ Sir J. Simpson (*Ed. Med. and Surg. Journ.* vols. i. and li.) discusses the influence of intra-uterine peritonitis in producing certain congenital herniæ, malformations of the abdominal viscera, &c.

⁵ *Loc. supra cit.* p. 22.

⁶ *Path. Soc. Trans.* vol. viii. p. 265, pl. iii. fig. 3.

⁷ *Loc. supra cit.* p. 24.

abdomen makes the above condition a probable cause of incomplete descent of the testis. The same opinion is thus expressed by Prof. Richet:¹ 'L'ectopie testiculaire inguinale est, sans contredit, de toutes la plus fréquente—on l'a trouvé dans tous les points du canal inguinal; le plus fréquemment il s'arrête à l'anneau externe, retenu par des bandelettes aponeurotiques qui circonscrivent cette ouverture.' (γ) *Want of power in the cremaster muscle*.—Mr. Curling,² who has been led from his investigations on this subject to conclude that the muscle of the gubernaculum and the cremaster are identical, believes that the above given condition may be, in some cases, a cause of incomplete descent of the testis. This belief is a rational one, but not yet proved, and scarcely admitting of proof. M. Follin³ states in support of this view: 'I have found, in examining the gubernaculum testis in a very large number of cases, that its size varies very much in fetuses of the same age, and often on the two sides of the same fetus. In certain cases all appearance of muscular tissue is gone, the muscular cord being replaced by a simple filament of feeble cellular tissue.' (δ) *Shortness of the vas deferens*.—This cannot be a frequent cause. As a rule, in cases of retained testis the vas deferens is of full length and arranged in tortuous coils. But in the following instance,⁴ which well illustrates many of the features of these cases, shortness of the vas deferens would appear to have been a bonâ-fide cause of the retention of the testicle.

In a patient, æt. 30, the right testis was to be felt in the inguinal canal just beneath the skin. For two years it had been painful and enlarged, and for two months the patient had been incapacitated from business. It caused an oval swelling, 6½ inches long and 5 broad, just above the groin. Some fluctuation and elasticity noticed at the outer extremity proved on extirpation of the testis to be a hydrocele containing 3ij. of fluid; a second sac at the inner part of the swelling communicated with the peritoneal cavity and discharged 3xxxij. of serous fluid. The testis had served as a valve to the internal ring so effectually that no impulse was perceptible on coughing. After a very severe attack of peritonitis the patient recovered. The spermatic cord was very short, only 1¾ inches long, and firmly attached to the posterior border of the testis, as if it penetrated it, rather than being a continuation of the epididymis. It had a fibro-muscular appearance, and was inelastic. This seemed to be a case of shortened vas deferens. The hypertrophy of the testis was of a fibrous nature, and due to inflammation. But the short and inelastic cord was not indurated, nor had it any adhesions, and when divided it was perceptibly contractile.

(ε) *Abnormal size of the epididymis*.—An instance of this is figured by Kocher⁵ from a preparation in the collection of Zürich. The testis here, small and pear-shaped and lying just within the internal abdominal ring, is surmounted by a huge helmet-shaped epididymis out of all proportion to it. (ζ) *A long mesorchium*.—The probable effect of this in suspending the freely movable testis in the abdominal cavity has already been alluded to (p. 464). Other causes of retention of the testis, which need but a bare mention here, are:—(η) Abnormalities of the internal genitals, as in the rare condition of synorchism or fusion of the two testicles within the abdomen, or in some of the various forms of hermaphroditism. (θ) *Pressure of a truss*.—This, applied in early life to keep up a hernia which has slipped down past an undescended testis, may later on prevent the descent of the testis also. It may be stated here that a testis which has normally descended into the scrotum may be drawn up again temporarily or permanently.⁶

Structure and functional efficacy of an incompletely descended testis.—This is a matter of very considerable importance, owing to the conclusion to which some of the best authorities have been led, that an incompletely descended testis is incapable of fulfilling its function. The question is, of course, only of real importance when

¹ *Traité prat. d'Anat.* éd. 5, p. 847.

² *Loc. sup. cit.* p. 21.

³ *Loc. sup. cit.* p. 269.

⁴ *Amer. Journ. Med. Sci.* vol. lvii. p. 100.

⁵ *Loc. supra cit.* p. 416, fig. 84.

⁶ An instance of the former is given by Szymanowski (*loc. supra cit.*), in which the testis, every time a sound was passed into the urethra, was drawn by violent contractions of the cremaster within the external abdominal ring, though this was undilated by any hernia, old or recent. In the *Med. Times and Gaz.* vol. xviii. p. 67, will be found the case of a man whose right testis had been suddenly and violently drawn up into the inguinal canal during masturbation, when he was young, and never reappeared.

both testes are retained. The subjects of even this condition are not incapable of sexual intercourse, but the possibility of their being fertile has been much disputed. Thus Mr. Curling¹ denies that an imperfectly descended testis is capable of secreting healthy fertile semen, and bases his belief on the following facts: (a) An incompletely descended testis is always small and undeveloped, and often, especially when in the inguinal canal, atrophied and the seat of fibrous and fatty degeneration. (β) No spermatozoa have been discovered in such a testis, nor in its duct, or in the corresponding vesiculæ seminales.² This has not only been the case in man, but also in some cases of cryptorchic stallions and dogs. On the other hand, (a) it is evident from the number of animals in which the testicles remain throughout in the abdomen, that there is nothing in this position at least which necessarily tends to impair the efficacy of the testis. (b) As a rule, no doubt, the structure of the testis in these cases, especially in those of inguinal retention, is one of atrophy. Thus the volume is diminished and the testis has a very fibrous appearance. What renders this more marked is that, owing to the atrophy of the gland tissue, the fibrous septa of the testis become more marked. As the unyielding tunica albuginea does not readily accommodate itself to the atrophy of the gland tissue, the testis is not only fibrous in appearance but flaccid to the touch. Even through the integuments this loss of resistance can often be made out. Later on a more complete fatty change sets in, though the form of the testis is still retained by the tunica albuginea. To this rule, however, there are exceptions, as in some of these cases the testis has been found to be of fair size and plump, and it has been possible to unravel the seminal tubules, which is never the case in an undeveloped gland. These exceptions are to be expected in cases of iliac retention, as here the testis is more protected. On this subject Sir A. Cooper's³ opinion was as follows: 'When the testis remains in the abdomen, it makes a strong impression upon the patient's mind, as an impression arises that his virility is lessened or destroyed. In a case of this kind I have known the unfortunate subject of it commit suicide. Yet the testis in this case and in others which I have examined was nearly of the same size as a healthy testis when deprived of its tunica vaginalis, and the seminiferous tubules were full of semen.' Even if it be allowed that this last remark of Sir Astley's loses some force, as it is not specially stated that the nature of the secretion in these cases was verified microscopically, one or two cases have occurred in recent years in which this precaution has been taken. It will be seen that the retention was in each case inguinal, and in one this condition was present on both sides.

The following case has been recorded by Dr. Beigel:⁴—

In a patient, æt. 22, the penis was well developed, but the scrotum formed only a small rudimentary empty sac. The inguinal canal on each side contained a distinct hernia-like swelling. In each of these a testis could be distinctly felt, that on the left side a little smaller, but by no means wasted. This condition caused no inconvenience. Coitus was practised frequently and vigorously; after any long interval nocturnal emissions took place. A specimen of semen examined from this patient contained a large amount of normal spermatozoa.

Another case has been recorded by M. Valette⁵ in which spermatozoa were found in the vas deferens of a testis retained in the inguinal canal.

(c) At least three⁶ cases have been recorded, comparatively recently, in which cryptorchids had married and begotten children. Mr. Curling has doubted the claims to paternity in these cases, as the seminal secretion was not examined, and as it is possible that the children were not, in these cases, the offspring of the putative fathers. This objection would, however, presuppose that the four wives of three cryptorchids (one having been twice married) were all unfaithful, a coincidence which would fit in very happily with the facts *a* and *β* given above, but which appears to me improbable, and its assumption scarcely justifiable. For it should be noted that

¹ *Loc. supra cit.* p. 27.

² That this is not universally the case is shown by the two cases in the text.

³ *The Testis*, p. 24.

⁴ Virchow, *Arch. Bd.* xxxviii. S. 144.

⁵ *Lyon Méd.* 1869. Le Dentu, *Anom. du Testicule*, Paris, 1869.

⁶ Curling, *loc. supra cit.* p. 437.

these men had all the signs of virility, and were undoubtedly capable of sexual intercourse, and could thus have given no ground of complaint to their wives, or supposed excuse for unfaithfulness.

Both sides of this question have now been considered. It is obviously one of considerable importance to the medical man, whose opinion may be asked in medico-legal cases involving paternity, and also by patients as to the advisability of marriage. In the present state of our knowledge no medical man will be justified in saying that all males, in whom both testes have descended imperfectly or abnormally, are necessarily incapable of impregnating the female. From the careful investigations of Mr. Curling such cases are to be looked upon with suspicion. It is very probable that the nine cases collected by Mr. Curling represent a rule to which the five above given (in two of which the spermatozoa were actually found, and in three were most probably present) are exceptions. But beyond this no medical man can safely go. When, in a patient who is anxious as to the advisability of marriage, there are no external marks of effeminacy, no want of the external characters of virility, no history of any injury or inflammation of the retained testes which can have altered their structure, the medical man will do well to state both sides of the question, and then, not having made light of the doubtfulness which is present in many of these cases, to leave the decision in other hands. It may be added that the position of the testes in the abdomen will be more favourable for the fertility of their secretion than their arrest down in the inguinal canal, owing to their greater liability, when in the latter position, to waste, from their exposure here to blows and the constant pressure of surrounding parts.¹

Diagnosis of misplaced or retained testis.—A testis retained near the external abdominal ring is liable, especially when it can be pushed back, or returns of itself, into the abdomen, often reappearing as soon as the patient stands up, or when pressure is removed, to be mistaken for a bubonocoele. The absence of one testis from the scrotum,² together with the peculiar tenderness on pressure and the shape of the swelling in the groin, will prevent the surgeon from being misled. The diagnosis in some complicated cases of retained testis, *e.g.* when a hernia co-exists, will be alluded to below (p. 474).

Treatment of retained testis.—This will of course depend somewhat upon the position of the testis and the age of the patient when he first comes under observation. If the testis be situated just below the external abdominal ring, a truss should,

¹ Mr. E. Owen concludes a paper 'On some Cases of Misplaced Testes,' *Clin. Soc. Trans.* vol. x. p. 192, with the following remarks:—

'It seems to me that cryptorchids might be arranged with advantage in three classes. In the first might be placed those who have neither the desire nor the power of sexual intercourse, but resemble those lower animals who have been castrated before development had far advanced.

'The next class would comprise those who have the desire, and that, maybe, in a marked degree, but whose whose power of fertilisation fails on account of the absence of seminal filaments. Such men would resemble many eunuchs and animals which have been emasculated when development was far advanced, or, possibly, perfected.

'In the last class would be found those cryptorchids who not only have the desire of healthy men, but whose semen is not destitute of spermatozoa—men who are apt to lead a miserable existence because they have been led to believe that because their testes have not reached the scrotum they are useless. With however much suspicion we may regard the paternity of children born to such men, it can hardly be denied that they may have the power of fertilisation in addition to that of intromission.

'But if the subject be fat and sleek, has a puerile or harsh voice, a small penis, and much adipose tissue heaped up over the symphysis, a scanty amount of silken hair on the pubes, and little or none on the face, then a fruitless search in the field of the microscope would scarcely be necessary to make us aware of his impotency.'

² Any such hint would seem superfluous, were it not so common for this point to be overlooked. Morgagni (*loc. supra cit.* p. 555) thus alludes to the same matter: 'The testicle when about to descend into the scrotum very late, as sometimes happens, . . . raises up the groin, yet cannot be easily mistaken for a bubonocoele, except by those who, not imitating Brechtfield (Bartholini, *Art. Med.* vol. i. obs. 106), neglect previously to examine the scrotum, especially in children.'

after the first two years, be constantly worn, the best being that with a horseshoe-shaped pad, introduced by Mr. Wood,¹ into the cleft of which the vas deferens or testicle is received. The same truss may be tried when the testicle is low down in the inguinal canal, in the hope that by a sustained gentle pressure the testis may pass through the ring. If a hernia² co-exist with the retained testicle, it is of course to be returned first. When this is impossible, owing to adhesions, two courses are open: either to return both the testis and hernia, or, where the patient is under puberty and it seems probable that the adhesions are of no great strength, an attempt may be made—if the patient be old enough to admit of the dressings being kept antiseptic—to separate the adhesions and return the intestine, and then, by an operation similar to that performed by Mr. Wood,³ bring the testicle into the scrotum.

(β) *Abnormal descent of the testis. Ectopia testis.*—This term has been applied to two abnormal positions of the testis. In one of these the testis, having left the peritoneal cavity, traverses the inguinal canal, and then, instead of going on into the scrotum, travels into the perinæum (*ectopia perinæalis*). In the other the testis leaves the peritoneal cavity by an altogether different route, viz. the crural ring (*ectopia cruralis*).

(a) *Ectopia perinæalis. Passage of the testis into the perinæum.*—This is much the more common of the two.⁴ The testis usually occupies one of two positions. It may lie in the fold between the scrotum and the thigh,⁵ or more posteriorly, just in front of the anus, close to the raphe,⁶ and usually on the left side. In these cases the cord can usually be felt running up along the cruro-scrotal fold to the external abdominal ring. The testis itself is extremely movable; it occupies a pouch which is usually beneath the deep layer of superficial fascia, and is surrounded by its tunica vaginalis; the skin over it is usually free from rugæ, and the scrotum on the corresponding side is often, but not always, undeveloped. In some cases a distinct band can be felt subcutaneously, which causes the mobile testis to return when shifted from its former position.⁷ Passage of the testis into the perinæum, though of course usually congenital, is not invariably so. Thus in the case of M. Godard's, referred to below, the testis remained in the inguinal canal up to the twenty-fifth year, and then travelled into the perinæum, lodging in front of the anus.

The causes of ectopia perinæalis are quite obscure—probably some irregularity in the attachment of the gubernaculum is one. Imperfect development of one-half of the scrotum can scarcely be assigned as a cause, as it is occasionally well developed in these cases.

A testis so misplaced will, in patients of active life, be much exposed to injury, and is likely to prove the source of much inconvenience. It is especially in sitting, and, later on in life, in riding, that its presence will give trouble. That it also, like

¹ *Med. Times and Gaz.* 1864, vol. i. p. 223, fig. 1.

² Further and more serious complications with hernia are mentioned p. 474.

³ *Lancet*, 1880, vol. i. p. 681. In a boy æt. 13, whose right testis was absent from the scrotum, a solid, painful, irreducible tumour, without impulse on coughing, was found at the right external ring. Application of an ice-bag for a week was followed by return of the testis to its original size, but it was still irreducible. On exposing it by incision, the cavity of the tunica vaginalis appeared to have been obliterated. The testis was attached to the pillars of the ring by very firm adhesions, which were broken down with difficulty. The cord, which was much shortened, was freed for an inch and a half, and the testis brought down into the scrotum, and secured by a catgut stitch. The operation was performed antiseptically. The patient recovered uninterruptedly, and went out wearing a truss specially constructed to keep the testis in the scrotum.

⁴ Thus Förster has collected eleven cases, *Jahr. f. Kinderheilkunde*, 1863.

⁵ This can scarcely be called in the perinæum; when, however, as is often the case, one-half of the scrotum is wanting, the anterior boundary of the perinæum is deficient in part.

⁶ An excellent instance of this condition from a patient under the care of M. Godard is figured by Mr. Curling, *loc. supra cit.* p. 50. The testis in this case appears to be of the usual size. In a case examined after death by Mr. Ledwick (*Dub. Quar. Journ. Med. Sci.* vol. i. 1855, p. 76) the testis, though small and soft, contained spermatozoa.

⁷ Kocher, *loc. supra cit.* p. 413. Mr. Curling and Mr. Adams met with such bands in cases in which they operated on unsuccessfully. See also Mr. Annandale's case below.

a testis retained in the inguinal regions or the iliac fossa, may be the subject of other inflammations, is shown by the following case :—

A patient with gonorrhœa complained of a painful swelling in the perinæum ; M. Ricord, supposing it to be a perineal abscess, was about to open it, but discovered it was the testicle. He met with another instance of the same kind.¹ In both the swelling was due to gonorrhœal epididymitis.

Other cases which show the importance of recognising this displacement of the testis are given below.²

Owing to the annoyance and risk of injury with which a testis misplaced into the perinæum is increasingly attended as life goes on, an attempt should always be made to replace the organ in its proper position by means of a pad, strapping, and bandage. If this fail, and the corresponding half of the scrotum be deficient, the misplaced testis had better be removed as soon as it is evident that it will prove a source of evil to the patient. If, however, the scrotum be normal, an attempt should be made to replace the testis by operation. This has been done five times,³ certainly, in this country, and twice successfully. The following case was under the care of Prof. Annandale :—

The patient, æt. 3, suffered from pain in the region of the perinæum, which was increased by walking or running. The right side of the scrotum was found to be empty, but its skin and other tissues were well developed. The cord was felt to come out through the external abdominal ring, but instead of passing down into the scrotum, it could be traced to the right testicle in the perinæum. The displaced testicle was well developed, and lay under the skin and cellular tissue at a point to the right side of the middle line of the perinæum. Pressure over the testicle caused much pain. The left testicle was normal in situation and development.

An incision, commencing over the external abdominal ring, and extending halfway down the scrotum, was made on the right side, so as to expose the cord, which was then seized, and by means of it the testicle was drawn out of its abnormal position. This necessitated the division of some adhesions, and one fibrous band, attached to the bottom of the testicle above and the tuberosity of the ischium below, appeared to correspond to one process of the gubernaculum, and required to be cut across before the testis would leave the perinæum. The scrotum was now opened up more freely, and the drawn-out testis was placed in it, and securely fixed there by means of a catgut stitch passed through the bottom of the scrotum and lower part of the testicle. The opening into the perinæum, along which the cord and testicle had passed, was closed with catgut stitches, and a small counter-opening made at the most dependent part of the perineal cavity which had contained the testicle, so as to allow any fluid to drain away, and ensure the complete closure of the cavity and prevent the testis from passing into it again. The wound in the scrotum and groin was then stitched up, the whole of the operation having been performed antiseptically. The wounds healed up, and the patient was able to go home in about a month. Some months afterwards it was reported that both testicles were in the scrotum, and occupying much the same position on their respective sides, the only difference being that the right one felt a little smaller and harder, and was more deeply situated and somewhat more fixed than the left one.

The chief conditions upon which success in such an operation would appear to depend are :—(1) Not performing the operation till after the first or second year. There is no risk that the scrotum will have undergone serious atrophy by this time, and putting off the operation till this date will enable the surgeon to

¹ Le-Dentu, *Anom. du Testicule*, 1869 ; *Prov. Med. Journ.* vi. p. 264.

² In the *Brit. Med. Journ.* 1858, p. 549, is the account of a case in which the testicle was thought to have been dislocated into the perinæum by a blow upon the pommel of a saddle. The gland remained in its abnormal position, an inch in front of the anus. An operation was attempted by Mr. Partridge, for the purpose of replacing the testicle in its position. This being unsuccessful, the organ was removed. It is not improbable that this testicle had descended into the perinæum in infancy, but was not a source of annoyance till the injury upon the saddle. Dr. Zeis (*Archiv für klinische Chirurgie*, vol. ii. p. 81) was about to operate on a lad, æt. 15, for stone in the bladder, when he found the left testicle in the way of his intended incision, and he accordingly made the incision on the other side ; the left side of the scrotum was very small. He quotes other cases of abnormal descent of the testicle into the perinæum and crural region.

³ By Mr. Partridge, *Brit. Med. Journ.* 1858, p. 549 ; Mr. Curling, *loc. supra cit.* p. 53 ; Mr. Adams, *Lancet*, 1871, vol. i. p. 710 ; Prof. Annandale, *Brit. Med. Journ.* 1879, vol. i. p. 7. In the above the testis was transplanted from the perinæum. There is also Mr. Wood's case of transplantation of a testis from the groin, mentioned on p. 468.

keep his operation-wound antiseptic, the parts with which he has to deal being larger, and the evacuations of the urine and fæces more easily managed, than in the first year of life. (2) The division of all adhesions. (3) Stitching the testis to the bottom of the scrotum. (4) Closing the wounds above and below carefully, and making provision for free drainage from the most dependent part of the cavity in the perineum, from which the testis has been removed, to prevent all risk of tension, and so of suppuration, in the parts above.

In cases where the surgeon is called to a case where a testicle misplaced into the perineum is giving serious annoyance, and the patient is past the age of puberty, and the corresponding half of the scrotum is either all along undeveloped or atrophied from the continued emptiness, it will be wiser to remove the testis at once.

(b) *Ectopia cruralis.* Displacement of the testis through the crural ring.—In these cases the testis passes under Poupart's ligament through the crural ring in exactly the same way as a femoral hernia,¹ occasionally, like a large hernia in this region, mounting up along Poupart's ligament. As in other cases of misplaced or retained testis, symptoms of inflammation may be noticed here also, closely simulating those of strangulated femoral hernia. In some cases a femoral hernia has accompanied a testis which has travelled through the crural canal. Finally, the testis, like the ovary, may be found within a crural hernia.

The proper treatment of these cases is to return the testis, whenever this is practicable, within the abdomen, and retain it there with a truss. In any case which simulates a strangulated femoral hernia and needs exploration, or in one which gives persistent annoyance from the recurrent attacks of inflammation, the testis should always be removed, the operation being conducted with antiseptic precautions.

State of scrotum in cases of retained or misplaced testis.—This varies considerably. Sometimes the half which corresponds to the absent testis is only filled with fatty cellular tissue, and no trace of a tunica vaginalis is present. In other cases a distinct serous pouch is present. Where a testis in the inguinal canal is very movable and can be easily pushed down into the scrotum, though it returns as readily, the presence of a pouch of tunica vaginalis may be expected, and the same may of course be said of those cases where, though the testis itself is retained above in the canal, the vas deferens and epididymis have, to a greater or less extent, slipped down in front of it. The question of the existence of a patent tunica vaginalis will also be affected by the wearing of a truss, or by previous attacks of inflammation.

As evidence of how worthless external signs are, the following case, brought by M. Deville before the Société Anatomique ('Bull.' 1848, p. 32) may be quoted. The testis on the right side was entirely absent. The left was in the inguinal canal, very small and flattened; its vas deferens ran down to the fundus scroti and then ascended. In this case the scrotum showed no abnormality.

Complications of retained or misplaced testis.—These, which are given in a tabular form at p. 476, will now be considered seriatim.

Inflammation.—This may be due to several causes, most frequently traumatic, e.g. strains, blows, twists, &c. Its occurrence will be most marked and frequent in cases of inguinal retention, and especially when a testis previously mobile becomes forced from its bed above into a new and narrower situation, as when, in a young subject put for the first time to hard work, a testis is forced from the inguinal canal beneath the pillars of the external abdominal ring. The following is the kind of history that may be expected:—A swelling has usually been noticed from birth in the region of the groin; this is too often taken for a rupture, and a truss is worn but irregularly, owing to the pain. On some occasion of strain, blow, &c., the swelling is noticed to become larger, harder, and intensely painful; the onset of these

¹ In one case (Loder, *Journ. für Chir.* Bd. ii. § 187) the testis first descended into the inguinal canal, but having been pushed back into the abdomen, it escaped a second time by the crural canal.

symptoms being perhaps attended by the sensation of something giving way. Colicky pains in the abdomen, constipation, furred tongue, and nausea are not uncommon. The swelling is usually about the size of a hen's egg, for the most part solid, but in part often elastic or fluctuating; this latter corresponding to a portion of the tunica vaginalis into which acute effusion has taken place, as in the case related on p. 465. This swelling shows little, if any, impulse when the patient coughs. The integuments over it are natural, but exquisitely tender, the pain shooting up along the course of the ilio-inguinal nerve to the lower part of the back, and also over the hip. These attacks occur frequently, and though they yield to treatment, the parts feel sore and bruised for some days after each, and the patient is obliged to go about with the body bent forwards, from the increased pain which the erect position causes.

The following case,¹ which ended fatally from peritonitis, shows how grave the above inflammation may occasionally be :—

A boy, æt. 10, was brought to the London Hospital dangerously ill from acute peritonitis. Four days before he had been kicked in the right groin. On admission he was almost in a state of collapse, his pulse quick, small, and feeble; the abdomen hot, tumid, and extremely tender; the bowels were constipated, but they had acted since the accident. There was a considerable diffused swelling in the right groin, and the right side of the scrotum was empty. Death took place twelve hours after admission.

Post-mortem examination.—Extensive peritonitis was found throughout the whole of the abdominal cavity, the viscera being coated with lymph, and a turbid serum abundantly effused. Just beneath the peritonæum, in the right iliac fossa, were two small recent abscesses. An atrophied testis was discovered close to the external ring, amongst a mass of connective tissue, infiltrated with pus and lymph. There were indistinct traces of a tunica vaginalis continuous with the peritonæum.

In the following case² the inflammation of the retained testis was even more extreme, though happily more localised: the case also shows how closely inflammation of a retained testis may simulate strangulated hernia.

A lad, æt. 19, came to my out-patients at Guy's Hospital, Nov. 1879, with the following history :—The left testis had never descended into the scrotum. When the patient was fifteen months old a tumour appeared for the first time in the groin, with sickness and syncope. This attack passed off; no truss was applied, and no further trouble was experienced till the patient was about eleven, when the swelling again appeared. He began to wear a truss when about fourteen. Finding this very inconvenient, and no swelling having appeared for five years, he obtained permission from a medical man to leave off the truss. Two days after doing so pain returned in the groin. When I saw him the pain was intense; a hard defined swelling existed in the left groin, without impulse when the patient coughed. The abdomen was tense and full, and coils of distended intestine could be seen through the parietes. Constipation had existed for forty-eight hours, but there was no vomiting. Several small doses of liq. opii sedat. had been taken for the relief of pain. Believing that a piece of intestine, adherent to the testicle, had been drawn down by it and had become partially strangulated, I admitted the patient under the care of my colleague Mr. Howse, with a view to exploration. Shortly after, the following operation was performed, with antiseptic precautions, by Mr. Howse. An incision three inches long having been made over the swelling, and the coverings of the inguinal canal divided on a director, a bluish encysted swelling was found, with very vascular walls. On carefully puncturing this, it was found to contain the testicle in a condition of gangrene. On section it presented much the appearance of black currant jelly, traversed here and there by a few unaltered septa and tubules. Another black cyst-like swelling, with thinner walls, was found to be the epididymis, and above this the reddish, pulpy, cedematous cord. This was divided after being tied with carbolised silk; a few small arteries were tied with catgut, the wound closed with wire sutures, and the silk ligature on the cord brought out at the lower angle. The temperature never rose above 99·6°. The patient went out about a month after, feeling quite comfortable with a truss of low pressure, and walking well.

A few other causes of inflammation of a misplaced testicle have been met with, but here the origin has been non-traumatic. Gonorrhœal epididymitis has been the most frequent cause,³ and may also affect a testis misplaced into the perinæum⁴ as

¹ Mr. Curling, *loc. supra cit.* p. 37.

² This case was under the care of my colleague Mr. Howse, and is published with his permission.

³ Nine cases have been collected by Kocher, *loc. supra cit.* p. 421.

⁴ Ricord, as has been already shown (p. 469), met with two cases of this nature.

well as one retained in the abdomen or groin. The form of the swelling is of course not so characteristic in these cases as when the testis is in its natural situation in the scrotum; where the testis is retained in the groin, but the epididymis and vas deferens loop down in front of it into the scrotum (p. 464, footnote), great pain and tenderness will be complained of here, though the testis itself is absent.

Treatment of misplaced and inflamed testis.—This should be always palliative at first: neither the parents of a child who is the subject of this affection, nor later on the patient himself, will be willing to submit to any operation involving the loss of a testicle, until they have had abundant proof of how annoying the often recurrent crippling of this affection is, and how much it interferes with the prospect of a useful life. In the case of a child, poppy-head fomentations, rest, a warm bath, a powder containing a few grains of hyd. c. cret. and pulv. Dover. every four or six hours, with a little castor-oil if necessary, will be all that is required. In that of an adult, an ice-bag if the contact of this can be borne, and if this fail the application of leeches (six to twelve), followed by warmth, one or two doses of pil. hydr. followed by a saline antimonial draught, or the above-given powder in larger doses—these, with absolute rest, will quickly relieve the pain. After the first few hours, the application of a blister, if the patient will put up with the temporary discomfort, is often most efficacious.

From the case already given (p. 466) it will be seen that occasionally a misplaced testis causes no discomfort. The contrary is, however, the rule, and if after painful experience the patient is willing to submit to the loss of a troublesome, and probably now useless organ, the operation may be performed with confidence, as antiseptic precautions carefully carried out have much diminished the risk which a possible communication between the tunica vaginalis and the peritoneal cavity would entail.¹

Tubercular degeneration.—This is a rare complication of misplaced testicle.² Its rarity is perhaps explained by the fact that, owing to its altered structure, the testis in these cases does not readily lend itself to the changes which are summed up in the term ‘tubercular testis.’

Malignant disease.—With far greater frequency³ is this terrible complication of misplaced testis met with. It is especially when retained in the inguinal canal that the testis is attacked with malignant disease. Prof. Virchow, when discussing the origin of malignant growths in lesions resulting from mechanical injury,⁴ explains this frequency as follows:—‘It is certainly very remarkable that it is precisely in the cases where the testes remain between the walls of the abdomen that they develop, in a very large proportion of cases, malignant tumours (cancers, cystic growths, &c.), and that more frequently than in the cases where the testis is retained in the abdominal cavity, and still more frequently than in those where it has parted from the inguinal canal. In fact, when the testes are retained between the tendinous bands which are met with in the inguinal region, they are exposed to muscular contractions and to friction of every kind, and as at the same time in these cases they do not reach a high degree of development, their retention favours in a twofold sense the morbid predisposition of the organ.’

Prof. Cohnheim⁵ explains the frequency of new growths in retained testes on the supposition that, owing to the retention, the germs of growth (Wachstumskeime) present in the testis do not attain their regular development, and he draws attention to the similar frequency with which adenomata occur in the breasts of young unmarried women, and myomata in the uteri of sterile wives.

The variety of the new growth has not been exactly determined, but it is almost always malignant, either encephaloid carcinoma or a round-celled sarcoma.⁶

¹ In a large number of cases the same inflammation which has caused so much annoyance has shut off completely the cavity of the peritonæum, but the case quoted on p. 465 shows that this is not always the case, although no impulse may have been present on coughing.

² Such a case is mentioned by G. Fischer, *Hannov. Ztschr. f. prakt. Heilkunde*, i. 1864.

³ Thus Kocher, *loc. supra cit.* p. 422, has collected fifty-five cases.

⁴ *Path. des Tumeurs*, vol. i. p. 64. See also Prof. Virchow's *Handb. der spec. Path. u. Ther.* i. s. 338.

⁵ *Allg. Path. Bd. i. s. 643.*

⁶ Prof. Kocher (*loc. supra cit.* p. 423) says that three cases of cystic degeneration have been

The degeneration usually occurs before middle age,¹ and in strong subjects.

The following are the chief points which may be expected in these cases :—A patient, the subject of retained testis, and in whom the testis has more than once been the seat of injury and inflammation, notices that after one of these attacks the swelling does not subside. The testis, previously perhaps the size of a nut, is now found to be as large as a fist, tense, and for the most part solid, but usually at one spot showing signs of the presence of fluid. The swelling is without the usual impulse on coughing, and the natural testicular sensation is lost. The increase in size and pain is steady and often rapid,² the skin becomes adherent and dusky, with conspicuously enlarged veins, the lower extremity on the same side becomes œdematous, and death closes the scene usually within two years from the commencement of the malignant degeneration.

The above applies to malignant disease of a testis retained in the inguinal canal. Where the testicle so affected is within the abdomen, the case is at first by no means so clear.³ Obstinate uneasiness, soon amounting to pain, felt deeply in the iliac region, coming on first after some exertion, and liable to occasional and terrible increase ; an increasing tendency to sit and stand doubled up ; marked firmness and rigidity of the abdominal muscles ;—these points, together with the absence of one testis, may enable the surgeon to form a suspicion of the nature of the case, before any distinct tumour has made its appearance.

The frequency of malignant degeneration of retained testicles proves abundantly that they are liable to become, not only a source of annoyance, but also of absolute peril to the patient. Accordingly, removal is always to be recommended as soon as there is reason to believe that the above change has begun or is even impending. Extension of the disease upwards along the cord to the lumbar glands is quite as common in these cases as in malignant disease of a testis normally situated, and there is an additional motive for early operation in these cases on account of the greater difficulty of dividing the cord at a distance from the new growth.⁴ In the performance of this operation the steps of a herniotomy and castration must be combined ; in the case of a large growth the surgeon may find it worth while to tap any hydrocele⁵ first, or any portion of the growth that is clearly cystic, and an observation of Szymanowski's⁶ is worth bearing in mind—that where the new growth has

recorded and one of enchondroma. No further details, however, are given whether these new growths were found alone, or, as might be expected, they formed part of a malignant growth.

¹ The majority occurred between the ages of twenty-five and forty-five ; the youngest in a boy of seven (Koehler), the oldest in a man of fifty (a case of Mr. Hodgson, of Birmingham, reported by Mr. Arnott, *loc. infra cit.*)

² Two drawings, showing the size of the growth at ten months and at three years, will be found in the account of a case of encephaloid disease of a retained testis by Mr. Hodgson, of Brighton, *St. George's Hospital Reports*, vol. ii. p. 67. The models of the growth are in St. George's Hospital Museum.

³ The reader is referred to Dr. Johnson's paper, *Med.-Chir. Trans.* vol. xlii. p. 15, on a case of encephaloid cancer affecting a testicle which had been retained within the cavity of the abdomen.

⁴ In Mr. Arnott's case (*Med.-Chir. Trans.* vol. xxx. p. 9) a large 'medullary sarcoma,' originating in a testis which was retained in the right groin, was removed. On the patient's death, on the fifteenth day, from erysipelas of the head and face, 'a small deposit of encephaloid substance was found on the right spermatic cord, just within the inner ring, and a large mass in the root of the mesentery, which, owing to the patient's being fat, had not been detected during life.'

⁵ In a case, reported by Mr. H. Arnott (*Med. Times and Gaz.* 1871, vol. i. p. 11), of cancer of an undescended testis, in addition to a hard mass the size of a cocoanut, which represented the testis, there was very considerable thickening along the cord, reaching up into the abdomen, and having considerable impulse on coughing. During the operation for removal this enlargement along the cord was punctured. About six or eight ounces of yellow fluid escaped, and it was found that the finger could now be passed easily into the peritoneal cavity, the swelling consisting of much thickened tunica vaginalis. Peritonitis followed, this being perhaps accounted for by the prolongation and thickened condition of the serous membrane.

⁶ *Loc. supra cit.* This same writer has collected twenty-two cases in which a retained testis was removed for one or other of the above conditions. In no case did a fatal result follow

attained a large size the abdominal walls will be found much thinned, or even perforated, so that the diseased testis lies almost subcutaneous.

In the case of malignant degeneration of a testis retained in the abdomen, it will be right, after explaining the risk of such an operation to the patient, and the inevitable result if the growth be left, to give him the benefit of the chance of success. The probability of secondary deposits and of adhesions between the new growth and the viscera of the abdomen will of course influence the question of operation.¹ Enlargement of the lumbar glands can sometimes be made out by palpation, while œdema of the veins of the lower extremity, and evidence that the branches of the lumbar plexus are becoming involved, will render this more certain. The incision, whether median or one vertically upwards from the iliac region, should be made sufficiently free to prevent any risk of bruising the edges of the wound, and so setting up sloughing or peritonitis, by squeezing a large tumour through a narrow outlet. The bulk of the tumour may be diminished by tapping, great care being taken to prevent the escape of the contents of any cystic portion from reaching the abdominal cavity, and also to remove any blood, &c., from the same cavity when the tumour is removed.

Only one or two such operations have been recorded. Mr. Spencer Wells has operated in one such case,² the following details of which he has kindly forwarded to me. The apparent protection given by the capsule in this case, and absence of any secondary deposits, are very remarkable.

'The patient was a middle-aged German gentleman. The right testis was cancerous and undescended, and (including two to three pints of fluid in a cyst) weighed nine pounds. The incision was like that for ovariectomy in the middle line of the abdomen, and six inches long. The capsule (tunica vaginalis) was divided and the tumour shelled out of it; the capsule was otherwise not disturbed. There were no visceral adhesions. The operation was very easy; a few vessels only required to be tied, the ligatures being cut short and left in. Death took place on the fourth day, from septicæmia. I used a thymol solution (1-1000) for spray, sponges, instruments, &c., and I was strongly impressed at the time with the belief that the patient would have recovered if I had used carbolic acid. There was no disease of the lumbar glands.'

Dr. Czerny³ has apparently attempted it in another case.

A man, whose right testis had never descended, had a small and intensely painful tumour existing in the abdomen. On abdominal section it was found that a tumour the size of an ostrich's egg, and apparently bounded by a tunica albuginea, lay over the front of the lower part of the spine, firmly bound to this and the aorta by fibrous tissue. The ureter ran over the anterior surface of the tumour. Extirpation was found to be impossible; but the patient made a good recovery from the operation, and is said to have been relieved by it.

Complication of misplaced testis with hernia.—This occurs usually in one of the two following ways—(α) from adhesions having taken place between the testis and some portion of intestine (p. 464); (β) from coexisting patency of the tunica vaginalis.

This complication of hernia, as it usually occurs—*i.e.* in its reducible form—has been already alluded to (p. 468). It remains to consider here the complication of misplaced or retained testis with strangulated hernia. To put the surgeon on his guard, attention has already been drawn to the fact that strangulated hernia may occur with any of the varieties of misplaced testis; but it is, of course, the co-existence of a strangulated bubonocèle, or scrotal hernia, with a testis retained in

immediately upon the operation. Ten of the patients in whom the testis had been extirpated for malignant disease died of a recurrence, which took place within a period varying from a month to two years.

¹ In Dr. Johnson's case, which apparently had a duration of ten months, the diseased testis was found at the post-mortem examination to weigh about twenty pounds. Adhesions, which were broken-down without much difficulty, existed between the anterior surface of the tumour and the wall of the abdomen, and also about the right iliac fossa: there were no visceral adhesions.

² The case is alluded to, *Brit. Med. Journ.* 1879, vol. ii. p. 3.

³ *Arch. für Chirurg.* Bd. xxiii. Hft. 2.

the inguinal region, that is the most frequent and the most important. There are two conditions under which strangulation of a hernia is more likely to be of especial gravity, because of its acuteness. These are :—(1) When a loop of intestine descends suddenly past the testicle into a portion of the funicular process of peritonæum, which remains imperfectly obliterated, and which may reach down into the unoccupied half of the scrotum. (2) When a portion of intestine, with now its own peritoneal sac, which has for some time appeared in the inguinal canal, is driven down by some unusual exertion into the narrow external abdominal ring. In either case, but especially in the latter, if the scrotum be little developed, and therefore inextensible, the portion of intestine, on emerging from the external abdominal ring, may ascend upon the aponeurosis of the external oblique muscle, appearing in the groin as a superficial tumour reaching outwards from the external abdominal ring towards the anterior superior iliac spine.¹

The points which appear of the greatest value in enabling the surgeon to decide upon the nature of the swelling and the necessity of any operation will now be given.

In the first place, it must be remarked that the history, which would *à priori* seem to be of great help in these cases, occurring as they do in adults, is of little value, owing to the obtuseness or impatience of the patient, natural, or brought about by acute and unwonted suffering.

The local condition presents for examination (*a*) the condition of the scrotum. But here it is noteworthy that the presence or absence of a testis may be obscured by the presence of intestine, vas deferens, or epididymis, which have descended while the testis is still above; or by the effusion of blood or inflammatory products into the scrotum, from manipulation of the swelling above. This, which is most perplexing, may be recognised by the ecchymosis of the skin of the scrotum, when this coexists. (*b*) The characters of the swelling in the groin, if this recall the definite and characteristic shape and size of a testis contained in a tunica albuginea, allowance being made for enlargement due to the past or present attacks of inflammation, and if the natural feel of solid resistance and testicular sensation be present. On the other hand, irregular shape, resonance to percussion, elasticity, or the sensation of a granular uneven body, will point to intestine or omentum.

With reference to general symptoms, it has been already stated that when the surgeon has to deal with inflamed retained testis, the symptoms, though acute, are chiefly local and yield readily to treatment. But, on the other hand, when vomiting, though intermittent, is persistent;² when constipation is absolute, flatus even not being passed; when there is any swelling or tenderness of the abdomen, starting from the iliac fossa on the affected side; when there is much pain referred to the region of the umbilicus, the swelling is probably due to the presence of intestine, and an operation is called for. While exploring the swelling the surgeon must bear the following points of difficulty in mind :—When the inguinal canal is sufficiently opened it will be a question whether the swelling that presents itself is a hernial sac or a testis in its tunica vaginalis distended with fluid. If the symptoms have been acute or of any duration, this swelling is always to be opened, with the usual precautions in opening any hernial sac. If its contents are, as is only too probable, blood-stained serum and congested small intestine, the point of constriction,³ which

¹ As in a case of Mr. Hulke's, where an oblique inguinal hernia existed on each side, together with retention of the testes. *Trans. Med.-Chir. Soc.* vol. xlix. p. 189.

² It is hoped that the case will be seen before that bad omen, stercoraceous vomiting, has appeared.

³ Every surgeon who has operated on many cases of strangulated inguinal hernia must have met with some where the constituents of the cord were spread out and separated from each other around the hernial sac. This is very likely to be met with in cases of retained testis complicated with inguinal hernia. In a case recorded in the *Lancet*, 1859, vol. i. p. 630, where the right testis had never appeared, a tumour suddenly appeared in the groin while the patient was carrying a weight of 107 lbs. During the operation, small intestine and omentum were met with; and after the intestine was returned it was found that the 'cord had been divided, it having so surrounded the external abdominal ring as to appear a portion of the stricture.'

may be at either the external or internal ring, may require notching at more than one spot before the bowel can be returned; and when the constriction is high up, as at the internal ring, the surgeon must make quite sure that the intestine is entirely returned into the peritoneal cavity.

Complication of retained or misplaced testis with hydrocele.—It has already been shown that acute hydrocele is not uncommon in inflammation of a retained or misplaced testis. Like the enlargement of the inflamed testis itself, the effusion of fluid rapidly yields to appropriate treatment. Under other circumstances a more chronic effusion of fluid may also gradually appear in any portion of the tunica vaginalis which remains unobliterated about a retained testis. In the case mentioned on p. 465 this collection of fluid took place above and below the testis. Occasionally a tubular collection of fluid is present in the unobliterated processus funicularis, and this may communicate with the peritoneal cavity, the process being sometimes so thickened (p. 473) as to render the diagnosis very difficult.

Where a hydrocele complicating a retained testis seems to call for treatment, the directions given below may be referred to: where a communication seems to exist with the cavity of the peritonæum the radical cure by antiseptic incision is indicated (p. 488).

Complications of misplaced testis.—In the following table will be found those diseases which are connected with the descent of the testis:—

Retention of testis—(1) in abdomen; (2) in iliac fossa; (3) in inguinal canal; (4) just outside external abdominal ring.

Abnormal passage of testis—(1) into perinæum; (2) through crural ring. Inflammation from blow, pressure of abdominal muscles, &c. Gangrene. Peritonitis. Simulation of strangulated hernia. Gonorrhœal epididymitis. Tubercular degeneration. Malignant disease. Atrophy. Sterility.

Complication with hernia—(a) from adhesion of intestine to undescended testis; (β) from coexisting patency of tunica vaginalis.

Complication with hydrocele—(a) acute, from inflammatory effusion into some unobliterated portion of the processus vaginalis peritonæi; (β) similar effusion, but chronic. In either of the above cases there may be a communication with the cavity of the peritonæum above, or an extension into the scrotum below, according to the extent to which the above process is obliterated.

Inversion of the testicle.—Here the position of the parts is so changed that the vas deferens and epididymis present in front, being attached to the anterior part of the gland, the body of the testicle being behind. M. Maisonneuve and Mr. Curling have remarked that when present this abnormality is only met with on one side. It is, of course, a congenital affection. Its occasional occurrence must be remembered in the diagnosis of such diseases as epididymitis, both the acute variety and in that in which tubercular deposits are met with; and in the treatment of hydrocele and hæmatocele the presence of this abnormality may be of even greater importance.

HYDROCELE.

CLASSIFICATION.¹

- HYDROCELE.
- i. Of the testis
 - (a) *Hydrocele of tunica vaginalis*.—The fluid is in a sac connected with that of the tunica vaginalis.
 - 1. *Ordinary hydrocele*.—The fluid distends the closed sac of the tunica vaginalis (p. 478).
 - 2. *Congenital hydrocele*.—A communication exists between the cavity of the tunica vaginalis and that of the peritonæum (p. 490).
 - 3. *Infantile hydrocele*.—The cavities of the tunica vaginalis and that of the funicular process are distended with fluid, but these are shut off from the peritoneal cavity by a septum usually at the external abdominal ring (p. 492).
 - 4. *Inguinal hydrocele*.—Hydrocele in connection with a retained testis (p. 476).
 - (β) *Encysted hydrocele*.—The fluid is in a sac distinct from that of the tunica vaginalis.
 - 1. *Encysted hydrocele of the epididymis*.—The fluid is encysted in the neighbourhood of the epididymis (p. 493).
 - 2. *Encysted hydrocele of the testis*.—The fluid is encysted between the tunica albuginea and the inner surface of the tunica vaginalis (p. 498).
 - ii. Of the cord
 - (a) *Diffused*.—The fluid being a serous collection of the nature of œdema in the cellular tissue of the cord (p. 500).
 - (β) *Encysted*.—The fluid being contained in a distinct cyst originating usually in (1) some unobliterated part of the processus funicularis (p. 501); (2) in a cyst formed independently of the processus funicularis, *e.g.* in dilatation of persistent tubules of the organ of Giralès (p. 501).
 - iii. Complication of hydrocele
 - (a) *With other coexisting hydroceles* (p. 502)—*e.g.* (1) hydrocele of tunica vaginalis with encysted hydrocele of testis; (2) hydrocele of tunica vaginalis with encysted hydrocele of cord; (3) hydrocele of tunica vaginalis with diffused hydrocele of cord.
 - (β) *With hernia* (p. 503)—*e.g.* (1) Hydrocele of tunica vaginalis with inguinal hernia; (2) hydrocele of cord with inguinal hernia.
 - iv. Hydrocele of the sac of a hernia (p. 504).

Acute hydrocele.—When the term hydrocele is used a chronic affection is usually inferred. Before the chronic and much more common form of hydrocele are discussed mention must be made of the acute variety of the disease.

This is seen in acute traumatic orchitis, more commonly in the various kinds of acute epididymitis, and also in inflammation of the tunica vaginalis after injection, the use of the seton, &c.²

The changes in this serous membrane, when inflammation runs high, are similar to those met with elsewhere. It rapidly loses its smooth and glistening appearance, becomes extremely vascular and covered by a layer of soft 'lymph,' richly corpuscular,

¹ The above is based on a classification given by Mr. Curling (*loc. supra cit.* p. 88).

² Acute hydrocele may also occur when the testis is retained or misplaced, and is the seat of recurrent attacks of acute inflammation.

with cells of various forms. Flakes of this corpuscular lymph, becoming detached, fall into the fluid, which at the same time is poured out into the cavity of the tunica vaginalis, and promote its coagulation. The epithelial layer is soon replaced by a layer of thick indifferent pyoid cells, probably resulting from proliferation of the escaped nuclei of the epithelial cells. In the sub-epithelial layer, and in the connective tissue proper of the tunica vaginalis, groups of rudimentary corpuscles are thickly scattered, some of which, collecting into masses, form purulent foci; while others, in parts where the inflammation has run less high, are converted into fibre-cells. Where the original serous membrane has been converted into a sort of granulation tissue, corresponding obliteration of its sac takes place elsewhere over more or less limited areas, adhesions form, and are gradually converted into fibrous tissue (fig. 100).

The fluid of such an acutely inflamed serous sac differs as much from that of ordinary hydrocele as the richly corpuscular and spontaneously coagulating fluid of acute pleurisy differs from the serous fluid in hydrothorax. The prognosis, on account of the tendency to absorption, is correspondingly good.

The frequency of some degree of acute hydrocele in epididymitis is readily explained by the fact that only subserous cellular tissue lies between that portion of the visceral tunica vaginalis which covers the epididymis and the epididymis itself. On the other hand, the comparative rarity of acute hydrocele after orchitis may be accounted for by the arrangement that immediately beneath the subserous cellular tissue lies not the structure of the testis itself, but the strongly resistant and protecting tunica albuginea.¹

HYDROCELE OF THE TUNICA VAGINALIS. COMMON VAGINAL HYDROCELE.

This consists of a collection of serous fluid in the sac of the tunica vaginalis. Until this serous fluid, of which, normally, only just sufficient should be formed to keep the parietal and serous layers moist, has collected in quantity, it is a mistake to speak of the cavity of the tunica vaginalis, the two layers being in contact and gliding freely upon each other.

Causes of hydrocele.—These are not yet entirely cleared up. A certain number of cases, as we have seen (p. 477), may be called acute hydrocele, their origin being clearly inflammatory, *e.g.* after a blow, or epididymitis. Again, when a hydrocele occurs in connection with the irritation of the enlarged testis of syphilis, or of the much rarer loose body in the tunica vaginalis (p. 513), it may be correctly said to originate in an irritation, a condition akin to inflammation, and easily passing into it, though here the term acute hydrocele cannot be applied.

But with regard to hydrocele of the tunica vaginalis that is ordinarily met with, it is still disputed whether it originates as some inflammatory effusion or as a simple dropsy. The following are the chief points on either side. Those who put forward an inflammatory origin might point (1) to the large proportion of albumen, which is greater than that present in ordinary dropsical collections (*vid. infr.*); (2) to the frequency with which a fibrinogenous substance² is met with in the fluid, and occasionally spontaneous coagulation;³ (3) the absence of any marked tendency to hydrocele in cases which would seem to predispose to it if it were a simple dropsical collection, *viz.* cardiac disease and large varicoceles. On the other hand, those who look upon hydrocele as a local form of dropsy, might reply with truth that no collection of fluid (however originating) in a sac, if situated like the tunica vaginalis, could

¹ Gendrin, *Hist. anat. des Infl.* t. i. p. 64, first drew attention to the fact that when the subserous cellular tissue extends directly into a contiguous organ, as it readily shares in the inflammation of the serous membrane above, it as readily transmits this inflammation; but when this subserous cellular tissue meets with some tissue very different to itself, its power of propagating inflammation is checked.

² Buchanan, *Proc. Phil. Soc. of Glasgow*, Feb. 1845; Schmidt, *Reichert und Du-Bois, Arch.* 1801, S. 555; Virchow, *Die krankhaften Geschwülste*, S. 157; *Arch.* 1847, i. p. 572.

³ This is rarely met with. The fluid in such a case would be similar to that effused in acute pleurisy. Such cases usually occur after injury, and are of good omen for spontaneous cure.

long exist or attain any size without being exposed to so much disturbance and irritation that the fluid would soon assume characters assimilating it to one originating in inflammation. Thus the presence of albumen, of fibrinogen, and even of little flocculent matters floating on the liquid, would be accounted for. The fact that hydroceles are infrequent in cases of general anasarca, cardiac disease and varicocele, is, no doubt, against the theory of a dropsical origin; but, on the other hand, with regard to the former diseases, the inactive life and recumbent position must be remembered.¹ With regard to varicocele, just as in a varicose condition of the veins of the lower extremity, the blood-current can still be carried on by the deep veins, so in varicocele, however marked the enlargement in certain veins be, there is always a sufficient number of small veins unaffected (fig. 113) to carry on the slowly-moving venous current. And the frequency with which some form of support is made use of in advanced cases is not to be lost sight of. To the above arguments, the entire absence of any history of inflammation in the great majority of cases may be added. Hydrocele of the tunica vaginalis usually commences insidiously and without pain, the attention of the patient being usually only drawn to the increasing size of the scrotum. This is not the history with which any affection, did it own an inflammatory cause, would be noticed to begin in a region with such sensitive surroundings as the tunica vaginalis.

I consider that in the great majority of cases the effusion of fluid commences passively, and without any irritation or inflammation to begin with, the causes predisposing to its production being the pendent position, the relaxed² and atonic condition of the cremaster and dartos, feeble cardiac circulation, deficiency of tone in the scrotal blood-vessels and lymphatics, together with, perhaps, a tendency to venous congestion from hepatic and renal degeneration. All these conditions, which combine to bring about a passive effusion, are naturally most active in middle life, this being the age when the ordinary hydrocele of the tunica vaginalis is most frequently met with. After a while, as the fluid increases in bulk, it becomes, from exposure to friction, &c., liable to irritation and inflammatory changes which show themselves both in the fluid and in the tunica vaginalis itself.

Characters and constituents of the fluid.—The reaction of the fluid is neutral, the specific gravity varies from 1020 to 1025, 1024 being very common. It contains rather less animal matter than serum, though more than the fluid of ascites or hydrothorax, the amount of albumen in hydrocele fluid being about 6 per cent.;³ in that of ascites 4·25. It is odourless, deposits no sediment till becoming turbid from putrescence. Its colour is pale yellow, citron, amber, or of a greenish tinge, often darker in tint from an admixture of blood. In long-standing cases cholesterin⁴ is often present in pearly scales, diffused at first through the fluid and giving it a glistening appearance, and then, by rest, slowly subsiding. Occasionally the fluid resembles milk.⁵ On the whole, however, it is not very variable in appearance or

¹ Mr. Curling, *loc. supra cit.* p. 100, remarks as follows on this point: 'In disturbed states of the circulation from disease of the heart, the tunica vaginalis is not so frequently the seat of dropsical effusion as the other serous membranes, with the exception of the arachnoid; but this is partly owing to the pressure exerted around the testicle by the accumulation of fluid in the scrotum, and the relief to the spermatic vessels afforded by the œdema. In cases, however, of general anasarca, I have very frequently found slight effusion into the vaginal sac combined with œdema of the scrotum.'

² Dr. Viguier, *Le Progrès Méd.* 1877, p. 788, draws attention to the frequency of orchitis and hydrocele in hot climates. Owing to the flaccid condition of the scrotum, the testicles are more exposed to injury. The resulting attacks of orchitis being accompanied by hydrocele and the secretion of the tunica vaginalis not being absorbed, the frequency with which hydrocele is met with is explained.

³ Dr. Bostock, *Med.-Chir. Trans.* vol. iv. p. 73.

⁴ Occasionally in very old cases the only fluid found in the much thickened tunica vaginalis is a little thick, syrupy fluid, consisting entirely of cholesterin. For the difficulties of diagnosis in these cases, see the case on p. 484. The origin of the cholesterin is not yet fully known. Virchow, *loc. supra cit.*, attributes its origin to a fatty degeneration and shedding of the inner surface of the sac. From this fatty metamorphosis crystallisation results, and thus the cholesterin.

⁵ Such cases are recorded by M. Vidal, *Chir.* t. v. p. 176. In the *Path. Soc. Trs.* vol. xvi.

character. The quantity varies; usually it is under a pint, eight to ten ounces being a common amount; sometimes it amounts to several quarts. The hydrocele of Gibbon, the historian, is still, probably, without a rival in this respect, the quantity removed by Mr. Cline¹ in that case being six quarts. Microscopically, nothing is found in hydrocele fluid beyond a few epithelial or blood-cells, and occasionally cholesterin crystals.

Changes in the tunica vaginalis and in the other layers of the scrotum.—As a rule, but little alteration of the tunica vaginalis takes place for some time, the wall remaining thin and transparent, in spite of repeated tapplings. In advanced stages, however, from the prolonged irritation, &c., and more especially after any injury or effusion of blood, the tunica vaginalis becomes opaque and thick, the subserous connective-tissue is also thickened and condensed, being gradually converted into a kind of laminated fascia. In extreme cases of this hyperplastic thickening the tunica vaginalis may present to the unaided eye the appearance of cartilage, either over an extensive area, or as localised, projecting masses. Later on, as in other serous membranes, *e.g.* the pericardium, calcification may take place in this densely sclerosed tissue.² In addition to plates of this kind, or flattened masses, others of a similar nature, but different shape—*e.g.* warty, pedunculated, or polypoid—are not uncommon (p. 513).

It is of no slight importance to remember the possible existence of these alterations in certain cases, as where great thickening or calcification is present, the altered

FIG. 100. —Hydrocele, with adhesions of tunica vaginalis (Path. Mus. Univ. Camb.)



tunica vaginalis will be very evascular, and but little inclined to respond with mild inflammatory exudation to the ordinary treatment. Thus, if iodine injection be used, there is a risk that it will be without result; while if stronger methods are used, it is to be feared that sloughing of the dense evascular tissue will follow, with destruction of the scrotum and other grave sequelæ.

The cremaster is often, as in large herniæ, increased in size, this being partly due to a true hypertrophy, from the increased work which the muscle has to perform; but in part also to chronic inflammatory thickening of its intermuscular septa.

Arrangement of cavity of tunica vaginalis.—Usually this is single, and when much distended, pyriform in shape, from the extension upwards of the parietal portion along the cord. Occasionally, from the absence of this extension, or from its obliteration by inflammatory thickening, the shape is more circular.³ An hour-glass shape, the hydrocele ‘*en bissac*’⁴ of some French writers, is not uncommonly met with.

Here the constriction is due to a thickened band in the tunica vaginalis, rendering it more unyielding at this spot than elsewhere. In these cases the two cavities usually, but not invariably, communicate. The question whether synechiæ or inflammatory adhesions (fig. 100) can produce a bilocular or multi-

p. 184, a case is recorded which in all its external characters and history resembled ordinary hydrocele. The fluid was undistinguishable from cow’s milk by the unaided eye. Its sp. gr. was, however, 1019; that of milk being about 1030. The milky appearance was due to the presence of fat, as when shaken up with ether the liquid became transparent, and of the ordinary colour of hydrocele fluid. Conversely, on adding animal oil to the ordinary fluid, it became similar to the milky specimen. It was thought probable in the report on the above specimen that it was merely ‘ordinary hydrocele fluid plus some of the fatty matters of the blood, probably exuded by the capillaries of the tunica vaginalis.’ No spermatozoa were detected. Microscopically the specimen consisted of innumerable small globules, apparently composed of oil, and coated with albumen like those of milk, floating in a colourless liquid.

¹ Sir A. Cooper, *loc. supra cit.* p. 172.

² Virchow, *loc. supra cit.*, compares these to the dense plates met with on the spleen in peri-splenitis.

³ The pyriform shape which is said to be characteristic is best seen in infants.

⁴ For another variety of this, see below.

locular condition is one of great importance in treatment. From the facility with which most hydroceles are emptied by a single tapping, the presence of more than one cavity is certainly rare. Prof. Virchow¹ speaks of this alteration as not uncommon, and as usually met with on the sides of the epididymis. Mr. Curling² believes that more than one cavity is very rarely met with, and he believes that what is called a multilocular hydrocele is usually a form of the encysted, or a complication of the vaginal and encysted. Mr. Curling also, in reference to this subject, draws attention to the fact that one form of sac or pouch, which is often met with in hydroceles, is not commonly described. It is formed by the distension of the digital pouch, or depression of the visceral part of the tunica vaginalis between the testis and epididymis, and is thus situated on the inner side of the testis, though the opening into it is always found on the outer side, between the testis and epididymis. Dr. Béraud³ has described a variety of mixed hydrocele, or hydrocele 'en bissac.' In the course of a dissection he found a hydrocele consisting of two cavities—the one scrotal or superficial, the other the vaginal cavity proper. The former, the larger of the two, lay in front of the testicle, and was bounded externally by the dartos, its inner surface, white and smooth and polished, had all the features of a serous membrane. This and the vaginal cavity proper were joined at the upper part by an opening the size of a franc-piece, the borders of the opening being round and smooth. In discussing the cause of this peculiar hydrocele, Dr. Béraud puts aside the idea that it resulted from tapping and the non-closure of the puncture in the tunica vaginalis, and consequent collection of fluid subcutaneously, and also the theory that the two sacs developed independently and simultaneously. Having found on injection of the tunica vaginalis with tallow at a low pressure that an exact mould showed numerous processes of the serous tunic, which form glove-like diverticula, Dr. Béraud considers that the bilocular hydrocele may originate in one of these. During the formation of a hydrocele such a process becomes gradually distended; being less firm and resistant than the tunica vaginalis itself, it gradually forms a large pouch, surpassing in size the sac of the tunica vaginalis, and ultimately lodging itself in the cellular tissue of the dartos. Such hydroceles, as pointed out by Dr. Béraud, may be known by their extreme translucency, and by their more rapid development, the fluid meeting with less resistance in the dartos and skin than in the tunica vaginalis.

Position of the testis in vaginal hydrocele.—This is usually to be found at a spot on the posterior part of the swelling, and a little below the centre, where its position can be detected by pressure and by the translucency test. But irregularities in this arrangement, though uncommon, should be borne in mind. Thus the testicle may be at the lower and fore part of the hydrocele, owing to congenital inversion of the organ (p. 476). In other cases inflammation of the tunica vaginalis, leading to adhesions, may have caused the testis to become adherent in front before the formation of the hydrocele. In such cases the fluid bulges, and can be tapped on either side. On account of the undoubted existence of these varieties, the position of the testis should be ascertained, in every case, before any tapping is undertaken. And the reader should be here reminded that in large hydroceles, where the walls are tense and the testis projects into the cavity, it cannot be distinguished by manipulation.

Condition of the testis in vaginal hydrocele.—This is usually sound. It may be altered in shape, flattened by the pressure of the fluid, and in long-standing cases somewhat atrophied. But the glandular structure which remains is usually capable of exercising its functions, having probably been protected from the closely-contiguous inflammation by its tunica albuginea.

Period of life.—A hydrocele may be met with at all periods of life, but it is most frequent in infancy and at middle age. In the former case it is of course due to incomplete shutting off of the tunica vaginalis (p. 490). When a simple, uncompli-

¹ *Die krankhaften Geschwülste*, Bd. i. Vor. 48.

² *Ioc. supra cit.* p. 95.

³ *Archiv. gén. de Méd.* 1856, p. 670.

cated hydrocele of the tunica vaginalis appears in a young adult, a history of injury or syphilitic orchitis may be expected.

Side affected.—The relative frequency with which the right or left tunica vaginalis is affected has been variously stated.¹ But when a really large number of cases are collected for examination, it will appear that hydrocele affects the right or left side about equally. The following table is given by Prof. Kocher² :—

	Left	Right	Double
Bryant (117), and Curling (115) = 232 cases .	106	106	20
Socin 15 „ .	8	5	2
Baum 99 „ .	48	45	6
Langenbeck 69 „ .	28	31	10
415 „ .	190	187	38

It should, however, be stated that in a still larger number of cases (1,000) collected by M. Dujat,³ the left side showed a preponderance. The numbers here were on the left 324, on the right 305 ; 370 being double.

Symptoms of vaginal hydrocele.—Easy as the diagnosis of hydrocele usually is, there is no symptom which is absolutely decisive. The principal diagnostic sign is the transparency or translucency. This is best obtained in a darkened room by the surgeon grasping the neck of the tumour firmly but gently, so as to press its contents downwards, and forcibly distend and put on the stretch the lower part of the tumour. Supposing it to be a right-sided hydrocele, this is done with the left hand : the ulnar border of the right hand is then placed against the extremity of the tumour, while an assistant, holding a candle in his hand, brings the flame close to the opposite side of the scrotum, and holds it there steadily. Translucency may be difficult of detection where the sac is much thickened, or in cases where any blood is mixed with the hydrocele fluid (hydro-hæmatocele). In these cases aid may be sometimes given by the use of the stethoscope. Where this does not satisfactorily clear up the case, a careful antiseptic incision will be a wiser step than puncture with a grooved needle or fine trocar. This, however, will rarely be needful. It is obvious that a hydrocele cannot usually have become so thick as to lack translucency without the patient being probably able to give a history of previous tappings. But, on the other hand, it may be asked whether translucency is ever met with save in hydroceles. Prof. Humphry has carefully examined herniæ and other swellings for the purpose of ascertaining how far transparency may really be relied upon as an evidence of the presence of hydrocele or watery cyst in the scrotum, and has not found it to fail. That is to say, every swelling which has transmitted the light of a candle or the sun has proved to contain light-coloured fluid. Even in the hernia of young children, where the bowel and its coverings are thin, the light of a candle placed close to the part fails to shine through.⁴

As bearing on the above subject, the following case, which was under the care of Prof. Humphry, is of interest.

Transparent swelling in and near the inguinal canal proving to be abscess.—A young woman had a fluctuating swelling, as large as a turkey's egg, over the region of the right external inguinal ring, extending towards the pubes in the one direction, and along the course of the inguinal canal in the other. It was seen to be transparent when examined with a candle, and was thought possibly to be a cyst or collection of fluid in the canal of Nuck. It

¹ Mr. Curling. *loc. supra cit.* p. 98, found the majority of his cases on the right side. Mr. Osborn, *Hydrocele*, p. 21, considers that the left side is the one most frequently affected. Mr. Osborn, who has excluded all cases of traumatic hydrocele, thinks that this greater frequency on the left side may be explained by the greater dependency of the left testis, and the mode of exit of its blood into the renal vein.

² *Loc. supra cit.* p. 91.

³ *Gaz. méd.* 1838.

⁴ That this statement is not universally correct is shown by a case of Mr. Beck's, *Brit. Med. Journ.*, Dec. 9, 1882, in which a strangulated inguinal hernia in an infant of 10 weeks was 'quite translucent.'

had commenced two years previously, was gradually increasing, and was a source of much inconvenience. A careful incision was made into it, giving vent to a quantity of serum, followed by thin pus and masses of soft white lymph. It was evident that the pus-corpuscles and the lymph had subsided to the bottom of the abscess as the patient lay in bed, and had left the exposed part full of serum only, and therefore transparent. A free vent was given to the pus; gradually the discharge ceased, and the part healed.

In subacute orchitis or epididymitis the thin layer of fluid which is often present causes slight translucency, but this is very different from the more or less luminous mass met with usually in vaginal hydrocele.

The usually pyriform shape, the fluctuation, the dulness on percussion, the fact that the swelling cannot be returned into the abdomen, the freedom and normal condition of the cord, are all points to which attention should be paid.

The external characters of the swelling are also noteworthy, though not absolutely characteristic. Thus the swelling is usually limited to the scrotum, and does not involve the groin: it is smooth and uniform; and when the swelling is large the skin of the penis is so dragged forward that its body is buried, and its aperture is only represented by an opening like a button-hole, or one that recalls the umbilicus. Its progress is usually slow and painless, the direct inconvenience being due to its bulk and weight; the former impeding free movement and exposing the part to injury, and also causing annoyance from the fact that it causes an unsightly swelling apparent through the patient's dress, the latter producing an increasing pull upon the cord, and thus proving a source of discomfort referred to the inguinal and lumbar regions. The above-mentioned drag upon the penis, and consequent interference with micturition, &c., is another trouble which often causes the patient to have resort to tapping. Pain is very rare, and is usually only met with in cases of rapid re-collection of the fluid after it has been drawn off, in which cases the possibility of some admixture of blood, or of the rarer complications of a loose body in the sac of the tunica vaginalis (p. 513), is to be borne in mind.

Diagnosis of hydrocele of the tunica vaginalis.—It is in old hydroceles with thickened altered walls and condensed contents, that the transparency, fluctuation, smooth uniform surface, and comparative lightness will be wanting, and the diagnosis correspondingly difficult. The affections which are most liable to be mistaken for hydrocele are scrotal herniæ, hæmatocele, and some forms of new growth of the testis. The distinction of a hydrocele from scrotal hernia will usually be easy if attention be paid to the following points. The hydrocele begins at the bottom of the scrotum, and rarely reaches as far as the external abdominal ring (p. 492); whereas the hernia begins above, and gradually descends. The hernia usually gives an impulse on coughing, is resonant on percussion, or, if dull, gives the lobulated or irregular feel of omentum, can usually be returned with a sudden slip on pressure or characteristic gurgling, and often varies with the position of the patient, whether erect or lying down.¹ In hydrocele the cord can be felt distinctly above the tumour, but in hernia its presence is much less clearly marked. In hydrocele, as already stated (p. 481), the testis is not easily felt, especially when it projects into the cavity of a large hydrocele; in hernia, on the other hand, it is usually to be felt in the fundus scroti distinct from the hernia, save when this is congenital.

The diagnosis between hydrocele and hernia is especially difficult when the former extends upwards along the cord to the ring, or into the inguinal canal as high as the internal ring, and thus receives a distinct impulse on coughing (p. 492). If, in addition to this symptom, the sac is thick, or the contents of dark colour, and transparency thus absent, the surgeon will have only the history to go by, and the patient will often not have noticed whether the swelling began below or above. Here the doubt can only be cleared up by a careful antiseptic incision.

A hæmatocele is usually distinguishable from a hydrocele by the absence of

¹ An intelligent patient will often notice a diminution in the size of his hydrocele on first rising in the morning; but this, which is due to absorption, is quite different from the more rapid return of the hernia.

transparency, the greater weight, the obscureness of the fluctuation, the suddenness of the onset, and usually the history of an accident. But in certain cases of hydrocele of long standing, and where no history can be obtained, a careful incision with antiseptic precautions must be resorted to. Such an incision is to be preferred to puncture with a trocar, because more information is obtained by it, and because, if the swelling turn out to be a hydrocele with thickened sac, a free incision, followed by granulation, is, on the whole, the best treatment. The following case, which was under Prof. Humphry's care, is an illustration of the difficulties occasionally met with in the diagnosis of hydrocele.

A man, æt. 45, had swelling of the left testicle as large as a cocoa-nut, heavy as if it were solid, and with indistinct feeling of fluctuation; not the slightest transparency; slight constriction near the middle; large tortuous veins upon its fore part; the cord healthy. It was said to have followed a blow, after which the part became swollen and painful. The swelling continued, and the case was supposed to be a hæmatocele. Yet puncture with a trocar gave vent to twelve ounces of the ordinary straw-coloured fluid of hydrocele, and the sac was found to be much thickened.

The diagnosis between hydrocele and malignant disease of the testis will occasionally be obscure where in a long-standing hydrocele hardness and uneven surface, want of transparency, and obscureness of fluctuation, owing to the cartilaginous nature of the wall and the thickened contents, simulate the characters of the firmer or more fibrous carcinomata of the testis. The following cases illustrate the above difficulty.

A tumour¹ of small size in the scrotum of an old man was so irregular and uneven, felt so solid, and weighed so heavy, that it was impossible to determine exactly whether the swelling was occasioned by a morbid enlargement of the gland, a hæmatocele, or a hydrocele with the sac unusually thickened. Owing to the age of the patient, any operation was out of the question. After his death, from disease of the chest, the tumour was found to be a hydrocele, the sac of which was lined by an extremely dense false membrane, and contained a soft oleaginous substance, consisting chiefly of cholesterolin.

A man,² aged about 40, whose right testicle had been violently bruised, suffered persistently from acute pain in it for several years, the size of the organ steadily increasing all the time. The testis was hard, weighty, uneven, and, in addition to the fact that it was always acutely sensitive, it was also from time to time the seat of lancinating pains, such as are usually looked upon as almost characteristic of carcinomatous degeneration. M. Dupuytren pronounced it a sarcocele, and recommended extirpation, which was performed very shortly afterwards. The testis being exposed by an incision, the operator, having detected a fluctuating spot, in order to make sure of the diagnosis, plunged in the point of his bistoury; as there immediately followed a jet of liquid, reddish in colour and without odour, apparently analogous to what is found in the cysts of degenerating new growths, extirpation of the testis was performed.

On subsequent examination of the tumour it was found that it was entirely formed of a tunica vaginalis, which had become cartilaginous and of unequal thickness. The cavity which had been entered by the puncture at the time of the operation was nothing more than the proper sac of the tunica vaginalis; and the liquid which had escaped owed its qualities and colour to admixture with a certain quantity of blood. This had come from an opening exactly circular, with smooth edges, and about two lines in diameter, which, placed at the lower and posterior part of the tunica vaginalis, involved both this and the tunica albuginea. Through this opening could be seen the glandular substance of the testis itself, sound and healthy.

The diagnosis of the various complications of hydrocele will be considered later on (p. 502).

Treatment of vaginal hydrocele.—In a few rare instances spontaneous cure of a hydrocele has taken place, usually after some inflammation in the part, set up by a blow, or after non-traumatic epididymitis or orchitis, the cases being thus assimilated to acute hydrocele. Sir A. Cooper³ mentions cure by spontaneous sloughing of the scrotum, owing to excessive distension of its walls. Disappearance of a hydrocele without treatment in adults is, however, a matter of the greatest rarity. In them also the use of external remedies, iodine, blistering, pressure, is almost invariably futile, and not without danger, owing to the risk of sloughing of the scrotum. In

¹ Mr. Curling, *loc. supra cit.* p. 108.

² Dupuytren, *Lec. oral. de Clin. chir.* t. iv. p. 209.

³ *Loc. supra cit.* p. 177.

this respect, it is true, hydrocele is but an example of a class. In other diseases of the like kind—hydrocephalus, hydrothorax, hydrops articuli, &c.—the morbid change determining the accumulation of the fluid is slight, almost inappreciable, and the resistance to remedies is as great, or nearly as great, as in hydrocele.

The treatment of vaginal hydrocele is usually divided into (α) Palliative and (β) Radical, or Curative.

(α) *Palliative treatment*.—This consists in drawing off the fluid from time to time. The surgeon having always first ascertained the position of the testicle, takes a small trocar with a sharp point and well-fitting cannula, and thrusts this into the front of the hydrocele at about the junction of the middle and lower thirds, the affected side of the scrotum having been first made taut by grasping the neck with the left hand, and the forefinger of the right being placed on the trocar and cannula about an inch and a half from the point, so as to prevent too deep a plunge. Both trocar and cannula should be absolutely clean and devoid of rust. In making the puncture any large veins should of course be avoided, and the trocar should be entered quickly and vigorously, so as to make sure of entering the sac, especially when this is thick. The cannula, if rough or ill-fitting, is liable to push the tunica vaginalis in front of it instead of perforating it, this being made additionally likely if, by any wavering use of the instrument, the skin is first pricked, and the patient flinches. The direction of the trocar should be, at first, directly backwards, and then, as soon as the sac is perforated, upwards, so as to avoid the testicle. The trocar is now withdrawn while the cannula is pushed onwards with the forefinger and thumb of the right hand, the tension of the hydrocele being carefully kept up as the fluid flows away. A small bit of strapping should afterwards be applied to the puncture to prevent any drops escaping into the patient's clothes, and the patient will be more comfortable if he keep the part suspended. The operation is best performed with the patient standing with his back against a wall; but if he be nervous he may be placed recumbent on the edge of a couch. It is well also in any case to be prepared for the possibility of the patient's fainting. The patient should always be told to keep quiet and take as little exercise as possible for the first few hours. Erysipelas, severe inflammation of the sac, and sloughing of the scrotum have been known to occur occasionally even after simple tapping;¹ another untoward sequel, due to the absence of rest, being the formation of hæmatocele² (p. 506). Tapping a hydrocele should always be performed with a trocar and cannula; but where this is not possible, and the surgeon is driven to use the point of a lancet or tenotomy knife, the puncture is to be kept open by a director or a medium-sized gum-elastic catheter as the sac empties itself, otherwise the fluid will escape into the cellular tissue of the scrotum. The use of a lancet, it should be remembered, is more likely to cause a hæmatocele than that of the trocar. The period in which the fluid re-collects varies very much; usually fresh tapping is required every four or six months. Each case must be decided by the patient's sense of discomfort, mode of life, &c.

Acupuncture, which will be alluded to again in the treatment of hydrocele in infants (p. 492), has also been used in the palliative treatment of hydrocele. It consists in puncturing the hydrocele with a needle³ at several spots, and rotating

¹ Sir A. Cooper (*loc. supra cit.* p. 181) records two cases where this took place in elderly people who had taken long walks soon after the operation. In both inflammation of the scrotum took place rapidly, ran on into gangrene, and destroyed the patients within the week.

² Suppuration of the sac may occur after simple tapping in elderly subjects broken down in health. The swelling returns quickly, the scrotum being red, tender, and hard, with œdema of the skin. Pyrexia will be present, with, probably, rigors. The treatment is the same as when suppuration follows iodine injection, viz. a free incision into the anterior and lower part of the scrotum, washing out of the contents, and the passing a drainage-tube through the scrotum from the incision in front to a small opening on either side, so as to ensure free washing out of the sac. If the contents be very fetid, a little iodoform should be introduced. If free oozing take place after the contents are washed out, the cavity should be stuffed with lint-strips wrung out of carbolic oil.

³ In an adult, a cataract-needle is very handy; in the case of infants, an ordinary surgical needle is all that is required. Whichever is used, it should be scrupulously clean.

this slightly so as to enlarge the openings. Some of the fluid escapes externally, but most infiltrates the connective tissue of the scrotum, whence it is slowly absorbed.

This method, however valuable it may be in the case of infants, is very inferior to tapping with a trocar when the patient is an adult. It is not less painful, and it is certainly less speedy. In the course of a few hours the smooth uniform hydrocele swelling is replaced by œdema, which often takes a week to disappear completely. It is also inadmissible when the walls of the sac are thickened. Where the patient is very timid, acupuncture may be employed; or where, as in Mr. Luke's case,¹ the patient is forced to live abroad, out of the reach of any surgeon, he may be instructed to perform this operation upon himself.

(β) *Curative or radical treatment.*—The operations which have been brought forward for this purpose are extremely numerous. The only ones which will be considered here are—(1) Injection or introduction of stimulating substances; (2) Seton; (3) Antiseptic incision.

(1) *Injection or introduction of stimulating substances.*—Injection of liquids will be first considered. The variety of liquids made use of for this purpose has been very great; only a few will be here mentioned, viz. iodine, carbolic acid, port wine, and sulphate of zinc. *Iodine.*—This injection, which has been very largely used for the last thirty years, was first introduced by Sir R. Martin,² when practising at Calcutta. Before describing this method it may be stated that it is liable, like all others, to occasional failure. Sir R. Martin stated that in India the failures scarcely amounted to one per cent. I believe that in England, if cases are watched, failures will be found to be more common. In a paper written about five years ago³ I stated that, of forty-four cases which had been treated with iodine injection at Guy's Hospital, the treatment failed in eight cases, and in two it failed twice. Mr. Osborn⁴ gives a still larger proportion of failures. Of twenty-five cases from which Mr. Osborn succeeded in getting replies, recurrence took place in eighteen.

While I believe that the absolute certainty of iodine injection has been over-estimated, yet there is no doubt that failure is too often courted by want of the following precautions:—(a) The use of a too dilute solution; (b) not bringing the solution in contact with the whole of the sac; (c) not withdrawing all the hydrocele-fluid; (d) injecting large hydroceles immediately after they are emptied; (e) making use of the iodine injection in unsuitable cases, viz. hydroceles with thick walls.

The method of injection with iodine should be carried out as follows:—The fluid is first most carefully drawn off with a medium-sized trocar; the surgeon then, by means of a glass syringe, holding about half an ounce, with a platinum⁵ nozzle accurately fitting the cannula, injects steadily the iodine solution, taking care first that the cannula is pushed well into the sac of the tunica vaginalis. As soon as it is injected I plug the cannula with a small wooden spigot, while the affected side of the scrotum is carefully raised and gently manipulated and shaken, so as to bring the fluid in contact with all the interstices and folds of the tunica vaginalis. After about ten minutes half the fluid is allowed to escape and the cannula withdrawn, the puncture being held firmly around the cannula as this is withdrawn, and then closed with a piece of strapping. A feeling of heat is always noticed on the introduction of the injection, sometimes amounting to pain of a sickening character, referred to the part, and also to the inguinal and lumbar regions, occasionally to the neck of the bladder. To make sure of drawing off all the fluid I prefer to have the patient in the erect position, but there is no objection to allowing chloroform and the recumbent position to a patient who dreads the operation.

¹ Mr. Curling, *loc. supra cit.* p. 119.

² *Lancet*, April 30, 1842.

³ *Lancet*, Sept. 1, 1877. 'On Incision of Hydrocele antiseptically as a means of radical cure in certain cases.'

⁴ *Hydrocele*, p. 38.

⁵ Mr. Curling (*loc. supra cit.* p. 129) gives the hint that if a silver instrument is used, it should be immediately cleansed by dipping it in a solution of hyposulphite of soda (3j.—3j.), which will prevent the action of the iodine on the silver. This solution will also be found useful in removing iodine stains from the fingers.

The after treatment depends upon the amount of inflammation. This usually appears within three or four hours; and if it be delayed the patient should be told to walk about a little, and the sac again manipulated. When inflammatory action has set in, the patient should for the first few days be kept to his bed or sofa, the scrotum supported, and a plain diet given. The surgeon should be in no hurry to apply ice, this being only made use of if the pain is really excessive. Within a week usually, and often within four days, the patient may get about again, wearing a suspensory bandage.¹ He should always be prepared for a return of the swelling after the operation, otherwise he will be disappointed at what he considers a return of his disease. As a rule all swelling disappears within three weeks.²

The pain experienced after the use of iodine varies very much. As a rule it is too little rather than too much inflammation which is excited.

Attention has already been drawn to the necessity of pushing the cannula well into the sac of the tunica vaginalis before the iodine is thrown in; if by any mischance any escapes into the cellular tissue of the scrotum, punctures should at once be made, and hot fomentations constantly applied, as the risk of sloughing is now, in patients at all advanced in life, very great. The way in which iodine injections bring about a radical cure has already been mentioned (p. 477).

In the case of a double hydrocele, if the patient be healthy and not advanced in years, it is best to inject both sacs at the same operation; but where the surgeon is called upon to operate on a double hydrocele in an elderly or weakly patient, the antiseptic incision (p. 488) will be the safest treatment.

Carbolic acid.—This has been strongly recommended of late by Dr. Levis³ of Philadelphia, on account of the following advantages. (α) Carbolic acid produces almost uniformly the proper degree of inflammation, neither falling short nor exceeding that needful for producing plastic lymph. (β) It is less painful than iodine.⁴ After the usual tapping Dr. Levis, by means of a syringe having a nozzle sufficiently long and slender to reach entirely through the cannula, injects about 5j. of crystals of carbolic acid, maintained in a liquefied state by a five or ten per cent. addition of either water or glycerine. No more fluid is to be used for dilution than is absolutely necessary. Liquefaction by heat is inadmissible, as solidification is in this case liable to follow in the cannula. As soon as the carbolic acid is lodged in the sac the scrotum is freely manipulated, so as to diffuse the carbolic acid uniformly. A sense of warmth is produced, which is quickly followed by a decided numbness. The patient may walk about and attend to his duties for twenty-four hours, after which he had

¹ It is quite worth while to strap the testis as soon as the patient can bear it, i.e. about the tenth or fourteenth day, and to continue this every few days for a fortnight.

² The condition of the tunica vaginalis after iodine and other injections varies very much. Complete obliteration is, though desirable, by no means essential for success. A sufficient change in the minute structure of the serous membrane may occur so as to render the cure permanent, yet no adhesions be present. M. Hutin (*Arch. gén. de Méd.* 5^e Sér. t. ii. p. 218) has published the results of iodine injection (two-thirds of water and one-third of tincture of iodine) in sixteen cases, all of which had been cured. In eight only was there complete obliteration of the sac, in four there was partial obliteration, and in the remaining four no adhesions at all. In four, treated with wine injection, there was complete obliteration. Apart from the varying susceptibility to inflammation in different patients, it is probably the strength of the injection and previous changes in the tunica vaginalis itself that have most to do with a successful result. It is well known how common the latter become with advancing years. M. Duplay (*Arch. gén. de Méd.*, Août 1855) gives the result of examination of the tunica vaginalis in fifty-nine persons, whose ages ranged from sixty to eighty-six. The tunica vaginalis was more or less altered in forty-four; in twelve it was thickened; in seventeen there were adhesions; in fifteen there was hydrocele; and in four, cartilaginous or osseous bodies hanging by narrow pedicles.

³ *Trans. of Med. Soc. of Pennsylvania*, 1881, p. 687.

⁴ Mr. Hayes (*Brit. Med. Journ.* 1881, vol. ii. p. 936) recommends the introduction of iodoform through the cannula after tapping the hydrocele. The iodoform is introduced by a long, slender spoon, and is brought in contact with different parts of the cyst-wall. There is said to be little pain after the operation; and it is not needful to confine the patient to his room. No details are, however, given.

better keep quiet. Carbolic acid absorption and carbouluria have never been observed, the surface being probably sealed by the carbolic acid.

Port wine and sulphate of zinc injections.—These, though seldom used in the present day, must be mentioned here, as it was by means of these fluids that Sir A. Cooper and Sir B. Brodie cured their cases of hydrocele. Sir A. Cooper¹ considered a drachm of the zinc sulphate to a pint of water ‘an excellent injection.’ Sir B. Brodie² always employed equal parts of port wine and water. When these fluids are used, the injection is made by means of a large syringe or elastic bottle holding six ounces. The same precautions should be taken about throwing the fluid well into the tunica vaginalis. After about eight minutes the fluid is to be withdrawn. The sac of the hydrocele should never be over-distended with either fluid, for fear of forcing it into the cellular tissue of the scrotum; in either case rather less should be thrown in than was removed from the hydrocele. I have only had experience of port wine on one occasion, several years ago, where the injection of iodine had failed. The wine was, as recommended by Mr. Liston, undiluted, the specimen being a harsh and strong-bodied one. It cured the patient—but after suppuration.

Silver nitrate.—M. Maisonneuve, after withdrawing the hydrocele-fluid, introduced through the cannula on a grooved stilette a little powdered nitrate of silver, which was allowed to remain, a method which he preferred from its simplicity, harmlessness, and good results.

The use of iodine has, after a large trial, been preferred to all other stimulating substances in this country, owing to its comparative mildness and good results.

(2) *Seton.*—The use of this is to be limited to cases where previous injection with iodine, properly carried out, has failed, and where the patient refuses to have an incision made.³ A double silk ligature should be carried into the hydrocele cavity at its anterior and lower portion (the position of the testicle being first determined), and then made to emerge at a point about two inches higher up; the ends are knotted, and the silk is withdrawn in two to four days, according to the amount of inflammatory swelling. The objection to the seton is that it is liable to produce a high degree of inflammation, not easily amenable to treatment. Its employment in small hydroceles, *e.g.* of the cord, will be referred to below (p. 502).

(3) *Antiseptic incision.*—The treatment by incision is one of the oldest of all the methods for the radical cure of hydrocele. In former times, after free incision the tunica vaginalis was stuffed with lint, a proceeding usually followed by acute inflammation of the sac and severe constitutional symptoms.⁴ During later years incision has been successfully used in a few cases attended with considerable thickening of the sac by Mr. Curling. More recently the treatment of hydrocele by antiseptic incision has been carried out in Germany,⁵ and also in this country.⁶ In a paper published five years ago⁷ it was pointed out that this method undoubtedly involved more trouble than that by injection. Thus it can be completed in ten minutes, but an anæsthetic will generally be required, and there is also the trouble of subsequent dressings. Other disadvantages, that it requires longer time while it involves greater risk, are not really valid. After iodine injection the scrotum is rarely its natural size, and the patient free from all incumbrance, before three weeks; after antiseptic incision, the patient may get about in a fortnight. A small granulating surface may be left for ten days longer. But against the disadvantages of this rather

¹ *Loc. supra cit.* p. 185.

² *Lond. Med. Gaz.* vol. xiii. p. 92.

³ It may also be made use of with good results in small hydroceles which are difficult to fix before puncturing, owing to their tendency to slip away before the fingers or point of the trocar (see below, p. 499).

⁴ Mr. Samuel Sharpe, one of the earliest surgeons at Guy's Hospital, describes four cases treated by the old method of incision, in his treatise on the *Operations of Surgery*, published 1739. They are alluded to in the paper mentioned below.

⁵ Prof. Volkmann, *Ber. Klin. Woch.* No. 3, 1876; *Deut. Zeits. für Chir.* July 1876.

⁶ By my colleague Mr. Howse in his wards at Guy's Hospital. See also an account of some cases treated in this way by Prof. Lister, *Brit. Med. Journ.* June 26, 1881.

⁷ *Lancet*, Sept. 1, 1877. ‘On Incision of Hydrocele antiseptically as a means of radical cure in certain cases.’

longer period, and that the recumbent position must be enforced for a week instead of two or three days, may be placed the certainty of the method.

If it be objected that such an operation is severe, and involves risk, it is to be remembered that incising the tunica vaginalis with antiseptic precautions is totally different from the operation of incision as carried out a hundred years ago. Any one practising this method carefully will find the temperature very rarely rise above 99.8° , and that only during the first thirty-six hours, the constitutional disturbance present throughout being of the most trivial kind.

The following are the chief advantages of this method, together with the cases to which it is especially applicable.

Its greater certainty. In this it is superior to iodine injection or any other method. Failures after iodine injection have already been referred to (p. 486); as in the method by antiseptic incision the cavity is completely obliterated,¹ failure should be impossible. I have now operated in nine cases, three of them double. I have seen several of them since, and have never known or heard of any recurrence. Antiseptic incision of a hydrocele may be performed as follows:—The pubes and scrotum having been shaved on the affected side, an incision is made, with the usual antiseptic precautions, for two inches over the lower and anterior part of the hydrocele at its most prominent part. This incision should go down to the tunica vaginalis; and any bleeding vessel having been secured, the cavity of the hydrocele is to be opened by an incision of similar length. The fluid having escaped, the long stretched dartos rapidly contracts, almost closing the above incision. One or two sutures of catgut, or silk which has soaked for ten minutes in a 1 and 30 solution of carbolic acid, are then passed on either side, uniting the cut edges of the skin and tunica vaginalis,² and a short drainage-tube then inserted to the bottom of the remaining cavity. The usual dressings are then applied, the dry gauze perforated for the passage of the penis, and a spica bandage applied. These dressings will require changing within the first four days, and again about every four days, the drainage-tube being shortened as the cavity contracts. The patient may get up at the end of the week; after ten days or a fortnight the antiseptic dressings are dispensed with, and boracic acid lint or resin ointment applied, a suspensory bandage being worn for some time longer. There is no heat or redness³ after this operation, but for the first day or two some orchitis must be expected, though the severity of this varies extremely.

Antiseptic incision would appear especially applicable to cases (α) where iodine has previously failed; (β) where the sac is very large or has very thick walls; (γ) where, on account of ill-health⁴ or age, the risk of inflammation after iodine injection is especially to be dreaded; (δ) in cases of congenital hydrocele, a careful incision with antiseptic precautions will be safer than any other method of radical cure if the pressure of a truss for the obliteration of the communication with the peritoneal cavity cannot be persevered with; (ϵ) where the surgeon is desirous of exploring the sac of the tunica vaginalis, in cases where enlargement of the testis of a doubtful nature co-exists with hydrocele, and does not yield to ordinary treat-

¹ The antiseptic incision seems to bring about a cure partly by the extreme contraction of the sac which it causes, and partly by the alteration of the serous surface. The epithelial layer is detached from this in soft masses, adhesions taking place between the contiguous surfaces. No suppuration takes place, and no true granulations are seen. For the degree of inflammation required for a radical cure the reader is referred to p. 487.

² The importance of this point was not sufficiently insisted upon in the paper alluded to above. If these stitches are not inserted, the edges of the wound are inverted by the dartos, the wound is thus superficially closed, and it is impossible to make certain that entire obliteration of the cavity of the tunica vaginalis will take place from the bottom.

³ Occasionally the carbolic acid causes some erythema and redness. I observed this twice in my earlier cases. This, which causes temporary discomfort, may be entirely obviated by the use of eucalyptus dressings, an excellent and safe substitute for carbolic acid in cases where the skin is delicate or carboloria is dreaded. Of the latter I have never seen the slightest sign.

⁴ A case is quoted in the paper to which reference has been made above, in which the patient, an extremely unhealthy-looking man of about fifty, was suffering from a discharging carbuncle at the time of his admission. The case did perfectly well after antiseptic incision, the carbuncle healing while the sac was filling up.

ment, or in the much rarer cases of loose body in the sac of the tunica vaginalis; (5) where two hydroceles co-exist, *e.g.* either double hydrocele of the tunica vaginalis, or vaginal and encysted hydroceles; (7) in certain cases of hydrocele complicated with hernia, *e.g.* where the bowel is irreducible, and where, especially in unhealthy patients, there is a risk of the inflammation set up by the iodine extending to the sac of the hernia.

CONGENITAL HYDROCELE.

Here a communication exists between the cavity of the peritonæum and that of the tunica vaginalis. This is more likely to be found in weakly children, and in those which have been born prematurely.¹ The size of the communication is usually small—*e.g.* that of a goose-quill. That the chief part of the fluid comes from the peritoneal cavity is made probable by the fact that the hydrocele is distinctly larger, from gravitation downwards, towards evening in patients who have been up and about, and that, after pressure of a truss and obliteration of the communication, spontaneous absorption of the fluid is not uncommonly met with.

Where the opening is larger, a congenital hernia may coexist with the hydrocele. In these cases a portion of intestine or omentum may present at the aperture above for some time, and then gradually descend into the canal.

Symptoms.—Congenital hydrocele will be noticed very soon after birth; in addition to the other signs of hydrocele—*viz.* smoothness, fluctuation, and transparency—it is distinctly pyriform, with a prolongation upwards along the cord, and receives an impulse on the child's coughing or struggling. By careful, steady pressure on the scrotum the fluid may be returned into the peritoneal cavity; but it returns gradually and imperceptibly, although the finger be kept over the external abdominal ring.

Diagnosis.—Congenital hernia is often confounded with congenital hydrocele. Both are noticed soon after birth; both are continued upwards into the inguinal canal, and receive an impulse on coughing, &c.; and both are reducible, though in a different way. The diagnosis is usually easy if the points in the following table are kept in view:—

Congenital Hydrocele.

1. Is dull on percussion.
2. Requires even, steady pressure; goes back gradually, and without any slip, jerk, or gurgling sound.
3. Descends steadily but imperceptibly, though finger-pressure be kept up on the external abdominal ring.
4. Feels soft and even; no irregularity; gives no gurgling when manipulated.

Congenital Hernia.

1. Is resonant on percussion.
2. Requires less pressure; goes back quickly, often with a sudden slip or jerk, and with a gurgling sound.
3. Does not descend if finger-pressure be kept up on the external abdominal ring.
4. May be soft and even, or may be irregular; but often gurgles when manipulated.

The cases in which difficulty will be met with are those in which the communication is extremely minute, or valve-like. Here the fluid can only be returned, and an alteration produced in the size of the scrotal swelling, by steady, continued pressure, kept up, perhaps, for half an hour.

As has been already mentioned, there are a few other cases which are also puzzling,

¹ Prof. Roser (*Arch. für Physiol. Heilk.* 1858), in speaking of the causes of hernia, and amongst them of this communication, refers to the statement of Camper, that of 63 children born at full time in whom the testis had descended, the vaginal canal was obliterated only in 7, it being open on both sides in 34, on the right side alone in 14, and on the left side in 8. So, too, Prof. Engel (*Wien. Woch.* 1858) states that in children at birth, or during the first fourteen days afterwards, the vaginal canal is found oftener obliterated, or at least much shorter on the left side than on the right—a fact agreeing with the preponderance of hernia on the right side. He found the canal entirely closed at birth in 10 per cent. After fourteen days no trace of it could be found on the left side in 30 per cent., while it remained open on both sides at the end of fourteen days in 60 per cent. In the adult, the presence or the remains of the canal were observed in 31 per cent. of the bodies examined.

in which the testis is retained or misplaced, while a congenital hydrocele exists in the vaginal process which is prolonged to the external abdominal ring, or into the scrotum.

Treatment.—If the communication shows no disposition to close during infancy, and if attempts to remove the fluid by lotions containing vinegar, ammonia-hydrochlorate, tincture of iodine, &c. (p. 492), and attention to the health of the child and mother, have failed, as soon as the patient's age admits of it, the pressure of a truss should be carefully applied to the inguinal canal, and the fluid then withdrawn by acupuncture, or a very fine trocar. The pressure of a truss, if begun early and carefully persevered with, will produce obliteration of the neck of the sac in nearly every case. If the annoyance caused by the watching, &c., necessitated by the constant wearing of a truss by a young child is objected to by the friends, the surgeon must insist on the necessity of this. It is of the utmost importance to secure firm obliteration of the communication in these cases early, for two reasons. In the first place, if this be not done there is great risk that a piece of intestine will gradually be forced into the opening by the increasing movements of the abdominal walls. Another source of danger from an unobliterated communication is the facility with which inflammation may travel from the testis below upwards to the peritoneal cavity and its viscera. Thus Cloquet¹ mentions the post-mortem examination of a man, æt. 50, the subject of congenital hernia, in whom purulent peritonitis was present, having apparently originated below in inflammation of the testicle. No cause for the peritonitis could be found in the abdomen, all the viscera of which were healthy.

Where the pressure of a truss cannot be persevered with, or where a due trial of this treatment has failed, if repeated acupuncture or tapping are unsuccessful, the question of more radical treatment will arise.

The amount of risk which is entailed by injecting the hydrocele with iodine or other stimulating fluids will depend on the size of the communication. On this point, as already stated, the surgeon can gather information by watching the rate at which the hydrocele fluid can be returned into the abdomen by pressure.

Mr. Curling² considers that the patency of the communication in cases where pressure has failed need not deter the surgeon from making use of iodine injection.

If the surgeon makes use of this method, he should insist on a truss being worn during the operation, and for a day or two afterwards. A drachm of the tincture of iodine will be sufficient for the injection; and for fear of the inflammation running too high, all the fluid that is injected should be withdrawn.³

Another and safer course, but one involving the trouble of subsequent dressings, is to treat the hydrocele by antiseptic incision (*vid. supra*, p. 488). The lower half of the inguinal canal and the upper half of the scrotum is exposed, as in an operation for hernia, the vaginal process having been opened and the fluid evacuated, stitches should be applied as directed p. 489, and, in order to ensure obliteration from above downwards, a drainage-tube should be inserted and shortened at the successive dressings. If the patient is healthy, and the sac not thickened or adherent, the

¹ *Recherches sur les Causes et l'Anatomie des Hernies abdominales*, p. 144.

² Mr. Curling, speaking of the 'little risk which attends the injection of iodine into important serous sacs,' writes as follows: 'The little risk attending iodine injection in congenital hydrocele is confirmed by the immunity from peritonitis observed in those cases where the hernial sac has been injected for the radical cure of an inguinal rupture. Gosselin also notices this, and has cited three cases in which he operated in this way for the radical cure of hernia without the slightest symptom of peritonitis.' I would remark that this method of radical cure of hernia has never recommended itself to English surgeons.

³ French writers have described congenital hydrocele as apparently far more frequently met with in France than in this country. Thus M. Richard (*Gaz. des Hôp.* 1857, No. 41) speaks of having met with twelve cases in a month at the Hôpital des Enfants. M. Richard considers that the communication with the peritonæum is not of the importance that might have been expected. The following is the treatment recommended:—Complete evacuation of the hydrocele fluid with a very fine trocar, compression being exerted, by an assistant, over the inguinal canal and lower part of the abdomen; six to seven grammes of alcohol are injected and left in. Pressure is only kept up for a minute after the injection. The child is allowed to play about after the operation. The tumour entirely disappears by the tenth or fifteenth day, but a truss should be worn for three or four months.

surgeon may separate it carefully from its surroundings, as in the radical cure of congenital hernia: he should then ligature its constricted portion above with chromic acid catgut passed around it at one or two spots with an aneurism needle, and cut these short, care being taken not to include any part of the cord.

INFANTILE HYDROCELE.

This is very common, more so than the congenital hydrocele, of which it is a variety. In it the tunica vaginalis and the funicular process to a varying extent are distended with fluid; but this is shut off from the cavity of the peritonæum by a septum or partial obliteration of the serous surfaces, situated usually near the external abdominal ring. It depends on the fact that obliteration of the serous process has taken place above only, instead of above and below, close to the testis, simultaneously.

Symptoms and Diagnosis.—Infantile hydrocele is readily recognised by its early appearance, its smoothness, and marked transparency. It is distinguished from the congenital variety by the fact that steady, even pressure has no effect upon it, and that it shows much less diminution in size after the patient has been resting—*e.g.* in the morning. From hernia it is known by its transparency, the impossibility of reduction, and the absence of any gurgling when the swelling is manipulated.

Treatment.—Infantile hydrocele usually subsides spontaneously. This may be aided by the use of a lotion containing vinegar and water, spirit, or ammon. hydroch. gr. x.—aq. ʒj., or by careful external use of the tincture of iodine. Attention should also be paid to the health of the child and that of the mother, if the latter is still suckling. Where the above treatment has failed I have never known acupuncture to be unsuccessful. Half a dozen punctures are made with an ordinary straight surgical needle in the anterior and inferior parts of the hydrocele, the needle being slightly rotated before it is withdrawn. A good deal of oozing follows externally, but the chief part of the fluid escapes into the subcutaneous cellular tissue of the scrotum, whence it is usually absorbed. If any recurrence takes place acupuncture may be repeated. Where it fails, thread or fine silk soaked in iodine may be passed through the cyst and left for an hour or two (p. 488), or the antiseptic incision may be made use of.

Before operating by injection or incision on a case of infantile hydrocele the surgeon will remember the caution already given (p. 490), and make sure by steady continued pressure that no minute opening exists between the hydrocele and the peritoneal cavity. Absence of impulse, or of diminution in size when the patient has been lying down, also point to the infantile variety.

Occasionally the tunica vaginalis and the funicular portion of the cord remain unobliterated and in communication even in adult life, as appears to have happened in the two following cases, which were under the care of Prof. Humphry:—

In each it would seem that the canal remained pervious, except quite at the upper end; and that when hydrocele took place the sides of the canal yielded where it passed through the abdominal wall, and were also dilated into a considerable pouch behind the abdominal wall.¹

CASE I.—A man, æt. 35, had a large hydrocele on the right side, with a transverse constriction near the upper part. It extended up to the inguinal ring, and received an impulse when he coughed. On examination of the abdomen a fluctuating swelling was found at the lower part, like a distended bladder; and a distinct impulse was communicated from this to the scrotal swelling, so that it was clear there were two sacs, one in the scrotum, the other in the abdomen, communicating through the inguinal canal. The history was obscure. The patient was unconscious of any swelling in the abdomen, yet had worn a truss for supposed rupture. The scrotal swelling was attributed to a blow on the pommel of a saddle ten years before. It had gradually increased. A trocar passed into the scrotum gave vent to seven pints of serous fluid, emptying both sacs. The testicle lay at the inner and upper part of the scrotum. Pain and swelling of the left lower limb, with other indica-

¹ Prof. Syme relates a case of 'abdominal hydrocele' in a child aged four or five. The fluid was contained, not in the tunica vaginalis, but in an expansion of the cord (*Brit. Med. Journ.* 1861, p. 139). The dissection of a similar case is given by Mr. Lister in *Edin. Med. Journ.* Sept. 1856.

tions of plugging and inflammation of the femoral vein, followed. These subsided, and the fluid was on three subsequent occasions drawn off. A more radical proceeding being desired, an incision was made into the swelling, and carried up to the internal ring, so that there might be a free vent for the products of inflammation from the abdominal sac; lint was then inserted. Suppuration ensued; and when the wound healed, the cavity was obliterated in its whole length.

CASE II.—A man, æt. 29, had a hydrocele on the right side, extending through the inguinal canal into the abdomen, and causing a fulness above the internal ring. It resembled a hernia in its shape, in the impulse received by coughing, and in the fact that the testicle could be felt, apparently distinct from it, at the lower part; but it was transparent and fluctuating. It was attributed to a blow received ten years previously, and was said to have commenced in the scrotum. There was inguinal hernia on the opposite side. The swelling was incised cautiously, and lint was passed along the inguinal canal. Suppuration followed, and the disease was cured.

ENCYSTED HYDROCELE OF THE TESTIS.

The fluid is here contained in a sac distinct from that of the tunica vaginalis. Encysted hydrocele of the testis (this term being made use of to distinguish this form of encysted hydrocele from that which occurs in the cord) may be divided into two varieties:—

(i.) Common.—Encysted hydrocele of the epididymis, the fluid being encysted in the neighbourhood of the epididymis. (ii.) Very rare.—Encysted hydrocele of the testis proper, the fluid being here encysted between the tunica albuginea and the inner surface of the visceral tunica vaginalis.

(i.) *Encysted hydrocele of the epididymis.*—This is not uncommon, and is what is usually meant when the term ‘encysted hydrocele’ is used. Under the term encysted hydrocele of the epididymis two distinct kinds of cysts are met with, differing widely in structure and in clinical importance, and only having in common their position, which is always near to the epididymis. These two kinds of cysts may be distinguished as follows:—(a) Cysts small, subserous or external to the epididymis, unimportant, and never containing spermatozoa. (β) Cysts larger, originating within the tissue of the epididymis, important, and often containing spermatozoa.

(a) *Small subserous cysts.*—It is by no means uncommon to meet with small cysts the size of a pin's head, a millet seed, or a pea, projecting upon the free extremity of the head of the epididymis, and also, though more rarely, upon its centre or near its tail. They may be sessile or pedunculated. It is simply one or two of these little subserous cysts which form the so-called ‘hydatid of Morgagni.’ They are always on the surface of the epididymis, never being developed in its substance. In structure these small cysts are bounded by a fibro-cellular envelope, which is usually extremely thin, but occasionally so thickened that unless punctured the cyst might be taken for a solid body. Usually sessile, it is occasionally pedunculated, and thus may become a source of the so-called ‘loose bodies’ in the tunica vaginalis (p. 513). The liquid in the cysts varies; sometimes serous, yellow or limpid, it is in other cases turbid or opalescent. But however various in other characters, the fluid is constant in this, that it never contains spermatozoa or spermatid cells.

These cysts increase extremely slowly, never acquire a large size, usually remaining stationary when as large as a pea. Thus during life there is, as a rule, nothing to draw attention to their existence.¹

M. Gosselin² never found them in the testicles of children, only occasionally in subjects between puberty and thirty-five. On the other hand, after forty they became extremely common, being present in two-thirds of the testicles examined. In old men they were often found fibrous and pedunculated. M. Gosselin considers that in the varying frequency of these cysts at different ages lies the explanation of their origin. As the cysts lie superficially, and not in any relation to the structure proper

¹ Morgagni (*De Sed. et Caus. Morb.*), whose observation these cysts did not escape, believed that their rupture into the sac of the tunica vaginalis might, from irritation, lead to the formation of hydrocele.

² *Arch. gén. de Méd.* 4^e Sér. t. xvi. p. 24.

of testis or epididymis, as they can be dissected out entire, and as by fine injections no communication can be made out to exist between them and the seminal tubes, they cannot have originated in one of these. Rejecting this theory, M. Gosselin explains the increasing tendency, as life goes on, to the formation of these cysts, by the diminished activity of the testis. While the testis is functionless, in infancy or childhood, they are never found; during the time of its greatest activity they are very rare. On the other hand, after forty, and especially in old age, these cysts occur with great frequency. In other words, the testis has after puberty a powerful tendency to secrete. As long as the seminal fluid is secreted in abundance this tendency finds ample scope, but when this diminishes the above tendency becomes misapplied in the formation of these cysts.¹ If by this M. Gosselin means that as the substance of the testis and epididymis, becoming increasingly functionless, waste and shrink, the subserous connective tissue is here and there drawn out into cavities which ultimately become true cysts, it is easy to see a connection between the formation of these cysts and the functional activity of the testis; otherwise his view, ingenious as it is, appears to me too theoretical for acceptance.

If it be suggested that these small subserous cysts originate in traces of the Müllerian duct which have not been completely obliterated, it may be answered that if this were the case there appears no reason why these cysts should not be found earlier in life. The possible relation of the Müllerian duct to the larger encysted hydroceles of the epididymis is discussed below (p. 496).

(β) *Larger cysts often containing spermatozoa.*—These are usually found close to the upper part of the epididymis, either just above it, appearing as a continuation of it, a little below its head, or between the epididymis and the upper border of the testis. They arise beneath the external areolar investment of the epididymis, that is inside its structure, and thus in close relation with the seminal ducts, especially the vasa efferentia; from this circumstance the term ‘parenchymatous,’ as opposed to the more superficial and ‘subserous’ ones, has been given to them. They are usually single; more than two or three are very rare. In some cases when apparently multiple these cysts are compartments of a single cavity divided by delicate septa. The capacity of these ‘parenchymatous’ cysts varies very much; usually it is only a few (four to five) ounces.² As they increase, which they do very slowly and persistently, they may push their way between the epididymis and testis, separating them, and even unravelling the tissue of the former. By this means the vasa efferentia and coni vasculosi may become stretched over and spread out by such a cyst. The testis is usually in front and below; occasionally it is met with at one side; it is very rarely behind. In structure the cysts are composed of delicate fibro-cellular tissue and an exceedingly delicate tessellated epithelium may be scraped from their inner smooth and shining surface. The contents are often limpid and colourless, with only a trace of albumen, in both these points differing markedly from those of the ordinary hydrocele of the tunica vaginalis. It is quite exceptional to find the fluid of a straw colour and albuminous, and it is often impossible to find even a trace of albumen. The addition of acetic acid generally causes effervescence, from the presence of alkaline carbonates, and causes no cloudiness, as would be the case in a solution of mucus. The proportion of mineral salts is variable, the richness of the fluid in these corresponding chiefly to the age of the cyst, and not to the amount of spermatozoa present. Sodium chloride constitutes the chief part of the salts, the rest being a mixture of sodium phosphate and alkaline carbonate.

¹ M. Gosselin's exact words are—‘En un mot, la nature a donné à cet organe, à partir de la puberté, un pouvoir, un molimen sécréteur. Le molimen se réalise suffisamment tant que le sperme est séparé en abondance; mais lorsque vient à diminuer cette sécrétion, la tendance de l'organe n'est plus satisfaite, et le molimen se traduit encore par les productions accidentelles.’

² In the *Med. Times and Gaz.* 1853, vol. i. p. 629, will be found a case of bilateral encysted hydrocele in a man æt. 58. The united size of these was considerably larger than that of an adult head. On one occasion forty-nine ounces were drawn off from the right and fifty-eight from the left; at another time twenty-eight and forty-five ounces were withdrawn. The fluid was milky, and contained spermatozoa.

If not limpid and colourless, the fluid is usually opalescent, milky, or rather like weak soap and water, this being due to the presence of spermatozoa. These often show lively movements for some time after the fluid has been removed; at other times the spermatozoa are quite quiescent, or show signs of decomposition; thus all traces of their tails are lost, and only small oval nuclei-like bodies are found, which are, in fact, the heads of the spermatozoa. M. Gosselin has found that in a few cases spermatozoa abounded in the fluid of one of these cysts, though they were quite absent throughout the whole of the seminal tract.

The frequent presence of spermatozoa in these cysts has been much discussed, and numerous theories have been put forward in explanation of the fact.

(1) Mr. Liston,¹ who, contemporaneously with Mr. Lloyd,² but independently of him, first in this country discovered the spermatozoa in these cysts, thought that their presence might be explained by the cyst arising in a dilatation of a seminal tube. Those who put forward this view consider that it is supported by the free communication which often exists between these cysts and a seminal tube. The communication has been shown in different ways. Thus Luschka³ proved its existence by the passage of a bristle between the cyst and a tubule, and also by the injection of mercury. Mr. Curling⁴ and Mr. Quckett succeeded in injecting with mercury two encysted hydroceles by means of an injecting nozzle placed in the vas deferens. 'The metal passed freely into the epididymis, and escaped freely into the cyst attached to it in both testes. The ducts of the epididymis, loaded with mercury, were found ramifying over the walls of the cyst, having been drawn out and expanded by the growth of the hydrocele. On examination of the interior of the cyst the open mouth of the duct from which the mercury had escaped was distinctly visible. There was an oval opening in the membrane of the cyst, the edges of which were even and rounded; and at a point in the centre of this opening globules were seen escaping from a minute aperture in one of the ducts.'

Dr. Menzel, of Trieste, has recorded⁵ a case in which the communication seemed to be capable of proof in the living subject. Thus, when the testis was compressed the cyst became distinct, and *vice versa*.

Where no such communication exists it has probably been obliterated by inflammation in many cases.

(2) M. Gosselin⁶ considers that these cysts originate in the rupture of one of the seminal tubes, especially one of the vasa efferentia; some drops of seminal fluid thus escape into the surrounding connective tissue; the containing membrane, which gradually forms a cyst around the escaped fluid, after a time furnishes additional fluid, while the ruptured duct cicatrises and becomes obliterated by the development of the cyst. M. Gosselin considers that the rupture of the seminal duct is consecutive to its obliteration—a condition which he has shown to be not uncommon in the head of the epididymis. (See below, p. 497.)

(3) Mr. Curling⁷ believes that the rupture of one of the seminal tubes is a secondary step, the independent formation of a cyst in the connective tissue close by being the primary change. Mr. Curling has found in investigating these cases that in the majority of them a small cyst has long existed in a stationary state, and has enlarged after a slight blow; the consequent inflammation and admission of additional spermatozoa to the contents of the cyst having led to its increase in size. Mr. Curling supports his view by the undoubted frequency with which the ducts of the epididymis are stretched out by and spread over such a cyst (p. 497), a condition which is well represented in a preparation in the Hunterian Museum.⁸ An observation of Mr. Curling's that the spermatozoa are rarely found while the cysts are small, and are

¹ *Med.-Chir. Trans.* vol. xxvi. p. 216.

³ *Virch. Archiv*, vol. vi. p. 310.

⁵ *Lond. Med. Rec.* 1877, p. 249.

⁷ *Loc. supra cit.* p. 155.

² *Med.-Chir. Trans.* vol. xxvi. p. 368.

⁴ *Loc. supra cit.* p. 156.

⁶ *Arch. gén. de Méd.* t. xvi. 1848, p. 179.

⁸ This preparation is figured in Mr. Curling's book, *loc. supra cit.* p. 157. As in such a case the ducts will be liable to puncture during tapping of the cyst, it is obvious that the fluid withdrawn may contain spermatozoa, though none of these have been present in the cyst itself.

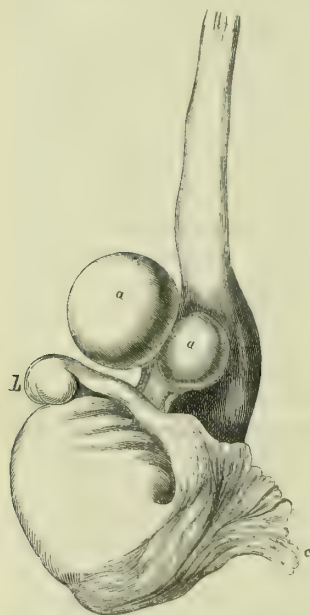
therefore usually not formed there originally, but are a subsequent addition to their contents, is also in favour of his view.

The following case, which was under Mr. Bryant's care,¹ probably illustrates the effect of a blow in causing rupture of a seminal tube:—

A man, æt. 60, had an encysted hydrocele of the left testicle, of twenty years' growth. The increase had been very slow till the last month, when the swelling had doubled its normal size; this rapid growth having followed an injury produced by a fall. The scrotum contained an irregular cystic swelling on its left side, evidently made up of several cysts, of which three of large size could readily be distinguished, the third being baggy. The testis was found on the inner side of the tumour. Tapping was at once resorted to, and the largest cyst emptied, many ounces of a milky fluid being drawn off. The second tense cyst was then tapped through the same opening, with the same result, and the fluid collected in a distinct glass. The third cyst was also tapped, but in this the fluid was quite watery. The first two contained abundance of spermatozoa; the third did not contain any. A good recovery followed.

(4) Another explanation refers the origin of these cysts and their contents of spermatozoa to certain fetal structures. It has been already stated that these encysted

FIG. 101. — Spermatic Cysts.
(Path. Mus. Univ. Camb.)



aa, closely connected with the upper part of the epididymis; *b*, spermatic cyst lying under the upper end of the epididymis and closely connected with the testis; *c*, tunica vaginalis reflected.

hydroceles occur with especial frequency in the neighbourhood of the head of the epididymis. Now, in this neighbourhood we have the three following relics of fetal structures, viz. (*a*) *The corpus innominatum, parepididymis, or organ of Giralaldès*²—that little body which lies in front of the cord immediately above the head of the epididymis, and beneath the upper part of the tunica vaginalis. This varies in size from a mere speck to a body four or five lines long, consisting of several minute irregular masses, which can be resolved into small convoluted tubes lined with squamous epithelium. M. Giralaldès considered that encysted hydroceles originated in the dilatation of the above tubules. It is well known to surgeons that encysted hydroceles originating near the epididymis, and containing spermatozoa, do sometimes extend far upwards along the cord. Such cysts when small may well have originated in the tubules of the organ of Giralaldès. Fig. 101 shows cysts in this position; insignificant as such fetal relics seem, it is of great interest to note that homologous and equally insignificant relics in female embryos may later on become the seat of formation of cystic growths between the layers of the broad ligament. (*β*) *Vestiges of the duct of Müller, especially the hydatid of Morgagni*.—It is well known that the above duct, which in the female forms the Fallopian tube, uterus, and vagina, becomes

almost entirely abortive in the male. Remains of it are always to be found in the hydatid of Morgagni, while in some cases the duct can be traced as it runs from the globus major, between the testis and epididymis in the digital pouch and so downwards to the globus minor, where it is lost amidst the other structures in the spermatic cord, to reappear again as the sinus pocularis in the prostatic urethra. The hydatid of Morgagni is constantly present between the top of the globus major and the testis, situated beneath the tunica vaginalis, and attached to the testis by a peduncle of varying length. Its structure is cystic normally, before any

¹ *Pract. of Surg.* 2nd ed. vol. ii. p. 186.

² *Bull. de la Soc. Anat.* 1857, p. 789; *Journ. de la Phys.* 1861. Henle, *Handb. d. Eingeweidelehre*, p. 364. Kölliker, *Handb. d. Gewebelehre*, p. 537.

changes are brought about by inflammation; the small fibrous cyst being lined with tessellated epithelium, and covered with the visceral layer of the tunica vaginalis. Two preparations in the museum of St. Thomas's Hospital¹ show clearly encysted hydroceles originating at the caput epididymis in the position of the hydatid of Morgagni. (γ) *The vas aberrans of Haller*.—This diverticulum, as a caecal tube arranged in a convoluted mass amongst the vessels of the cord, opens into the vas deferens at its commencement, or into the lower part of the epididymis. This structure, which is not always single, appears to be the remains of one or more of the tubes of the Wolffian body still adhering to the excretory duct of that body, which explains their communication with the tube of the epididymis or vas deferens. From the position of the diverticulum low down upon the excretory apparatus of the testis, and therefore at a point somewhat remote from the usual site of encysted hydroceles, it would not appear to be a common source of origin of these. Luschka,² however, has given reason for believing that occasionally this vas aberrans may form encysted hydrocele, as he has found it converted into a simple cyst.

Which of the above explanations is the true one must still remain somewhat doubtful. But the facts that these cysts so frequently originate in the neighbourhood of the head of the epididymis, and that in this same neighbourhood fetal relics abound, make it very probable that these encysted hydroceles originate in enlargements of hitherto quiescent foetal remains. Thus, when they are found higher up and encroaching upon the cord, they may have originated in the organ of Girdaldès; when somewhat lower down, the hydatid of Morgagni or some other unobliterated vestige of the duct of Müller may have been their starting-point. The question still remains, How do the spermatozoa find an entrance? In some cases, no doubt a communication remains unobliterated between the relic and one of the ducts at the head of the vas deferens, similar to that which exists between the vas aberrans and the vas deferens, and which has been proved to exist in other cases. If this be so, the frequent position of these encysted hydroceles near the epididymis will be in accordance with the frequency with which obliterations,³ temporary or permanent, take place in the tortuously coiled tubes of which this structure is composed, after inflammation, frequently venereal in origin (p. 527). Owing to such obstruction from inflammatory matting together of the surrounding peritubular connective tissue, regurgitation of the seminal fluid might take place from the vas deferens or one of the tubes of the epididymis into one of the above-mentioned foetal remains with which they are still in communication. But usually there is a simpler explanation of the entrance of spermatozoa. The slow but persistent increase in size of encysted hydroceles has been already alluded to, and the way in which they tend to spread out over their periphery the seminal ducts with which they come in contact. Dr. Moxon⁴ has pointed out that the fact that seminal fluid is not found in the cysts while small (p. 495) makes it very probable that it enters the larger ones from their opening a duct by pressure, just as bile enters a hydatid cyst. And when the situation of these cysts, on the outer part of the scrotum, especially exposed to friction, sudden slight blows, &c., is considered, the extreme probability of the above explanation will be recognised.

In addition to the above explanations of the origin of the spermatozoa found in encysted hydroceles there is another, put forward long ago by Sir J. Paget.⁵ This, though it has failed to find acceptance, cannot be passed over, on account of the weight and authority with which everything from the above-mentioned writer comes. Sir J. Paget, describing a globular cyst which originated near the upper part of the epididy-

¹ Prep. E. E. 69 and E. E. 70. The former is figured by Sir A. Cooper, *loc. supra cit.* Pl. xi. fig. 3. Here the cyst is of considerable size, and extends somewhat upwards along the cord. In the latter preparation the cyst is a very small one, and is in the exact position of the hydatid of Morgagni. It is figured by Mr. Osborn, *loc. supra cit.* p. 68.

² *Loc. supra cit.*

³ M. Gosselin, *Arch. gén. de Méd.* 4^e Sér. t. xiv. et xv. Lewin, *Studien über Hoden*, p. 16.

⁴ *Lect. on Path. Anat.* by Dr. Wilks and Dr. Moxon, p. 540.

⁵ *Med.-Chir. Trans.* vol. xxvii. p. 401. *Lect. on Surg. Path.* p. 418.

mis, and on its inner side, and which contained numerous dead spermatozoa, though at the time of the examination the cavity of the cyst was completely isolated from every part of the seminal tubes, put forward the following explanation of the occurrence of spermatozoa :—The most probable explanation of these cases, therefore, seems to be that certain cysts, seated near the organ which naturally secretes the materials for semen, may possess a power of secreting a similar fluid. And this explanation is in some measure supported by the analogy of those cysts which are found in the ovaries, and more rarely in other parts of the body, especially beneath hairy parts of the skin, and in which the ordinary products of the skin, such as epidermis, sebaceous matter, hair, &c., are formed on the genuine cutaneous tissue of their internal surface.¹

With reference to this explanation Mr. Curling¹ observes that it is not satisfactory, as the cysts in which the spermatozoa are found are not formed in connection with the secretory part of the organ, but with the excretory.

Again, even if it were granted that the above explanation might hold good for analogous cysts with simpler contents, it can scarcely do so in the case of these cysts, whose contents are a fluid so complex and unique as the semen; while their structure, a wall of connective tissue with a layer of tessellated epithelium, is yet so simple and unspecialised.²

(ii.) *Encysted hydrocele situated between the tunica albuginea and the inner layer of the tunica vaginalis, or in the substance of the tunica albuginea itself.*—These cysts are very rare. They are usually single and, from the resistance of their surroundings, of small size. Their situation is nearly always on the anterior surface of the testis. A specimen of this kind will be found in the Hunterian Museum. It was discovered accidentally by Mr. Curling³ in the course of a dissection. Mr. Hutchinson has described⁴ a case of thick-walled cyst which arose in the substance of the tunica albuginea itself. This formed a swelling about the size of a goose's egg, somewhat flattened, heavy and inelastic. Its upper five-sixths were rounded and tolerably smooth, and were separated by a depression from the lower part, which on pressure was proved to be the testis itself.

It is probable that these cysts, whether between the tunica albuginea and the tunica vaginalis or in the substance of the tunica albuginea, originate in hæmorrhage, the extravasation of blood being gradually encapsulated.

Symptoms of encysted hydrocele.—These are very little marked at first, the onset being very insidious, and the growth of these cysts extremely slow. Allusion has already (p. 495) been made to the fact that rupture of a seminal tube into one of these cysts after injury may bring about a rapid increase in size. While small these cysts feel something like, and have been mistaken for, an additional testis (p. 462). Their shape is often circular and somewhat bossy. When large or multiple the outline becomes irregular, but they seldom attain to the size of a hydrocele of the tunica vaginalis. In rare cases when they extend upwards along the spermatic cord their dimensions are considerable (p. 497). Thus Mr. Lister⁵ records a case of

¹ *Loc. supra cit.* p. 154.

² M. Gosselin (*Arch. gén. de Méd.* 1848, t. xvi. p. 178) writes as follows on this subject: 'Je rejette l'idée d'une transudation parce qu'elle est contraire à la physiologie, et pour la même raison je n'accepterai pas davantage l'opinion de la formation des animalcules dans le kyste lui-même, opinion avancée avec un peu d'hésitation par M. James Paget: d'abord les zoospermes sont les résultats d'une sécrétion portée à un très-haut degré de puissance; or, les produits sécrétés en général, et à plus forte raison ceux qui, comme celui-là, indiquent un grand déploiement des forces sécrétoires, ont dans tous les points de l'économie des organes spéciaux, des voies d'élaboration. Le produit se fait là et point ailleurs; pour le sperme et les animalcules, le lieu d'élaboration est dans les tubes séminifères, et les lois physiologiques ne permettent pas de croire qu'un kyste accidentel, sans aucune communication avec les tubes, puisse donner naissance à un produit semblable. Les kystes du testicule ne sont pas plus capables de produire des animalcules que ceux de l'ovaire des ovules et ceux du rein de l'urine.'

³ It will be found figured by Mr. Curling, *loc. supra cit.* p. 161, fig. 13.

⁴ *Path. Soc. Trans.* vol. vii. p. 246, fig. 6.

⁵ *Edin. Med. Journ.* 1877 vol. i.

a large encysted hydrocele with a history of only four years, which extended upwards into the inguinal canal, and also outwards above Poupart's ligament. It was conical, with the apex downwards, the upper part of the swelling being out of all proportion to that in the scrotum. A cure took place after injection with iodine. The cyst is above the testicle, and usually to one side of it; in other cases it is, in part at least, behind the testicle. Transparency is always present, and fluctuation also, unless the cyst be very tense. Considerable difficulty, however, may be experienced in making out these points when the cyst is small, *e.g.* of the size of a marble or grape.

Diagnosis of encysted hydrocele.—The transparency of the cyst, usually to be made out by careful examination, together with its fluctuation, absence of resistance, and density, will point out its nature. From ordinary hydrocele of the tunica vaginalis it may be distinguished by its usually slow rate of increase, one of these cysts often existing ten or twenty years before causing any inconvenience. The shape of the swelling is another point—when small, circular, or somewhat bossy, recalling the outline of a large marble; when larger or polycystic, irregular or somewhat lobulated, but never of the pyriform shape met with in hydroceles of the tunica vaginalis. The position of the testis should always be made out by the transparency test, or by careful pressure. If not below and in front, its usual position, the gland will be found below and at one side, usually the inner: it is hardly ever found behind the swelling.

In the majority of cases attention to the above points will be sufficient; but sometimes when the cyst is very small and difficult to fix so as to apply the transparency test, when the position of the testis is altered from adhesions, &c., a diagnosis can only be made by puncture with a fine trocar, when the character of the fluid will be another and decisive point.

Cases have been mentioned in which an encysted hydrocele of the epididymis extends upwards along the cord towards the abdomen; the history of the starting-point in these cases, the fact that the swelling cannot be separated entirely from the epididymis, and the result of tapping, will distinguish them from hydrocele of the cord. For the diagnosis from hernia see below, pp. 500, 502.

Treatment of encysted hydrocele.—On account of the slow rate of increase, occasionally stationary quiescence, and usually small amount of inconvenience attendant on this form of hydrocele, interference is less called for than in the ordinary hydrocele of the tunica vaginalis. So also, from the slow re-collection of the fluid, simple tapping will often suffice when anything requires to be done. Before adopting this measure the position of the testis is always to be made out. The cyst may usually be tapped on the outer side. If more radical measures are required, the surgeon must choose between iodine injection, a seton, and antiseptic incision.

In making use of iodine injection the same precautions are to be used as in the case of the more ordinary hydrocele. If the cyst be small and mobile it is imperative that the trocar should clearly have entered the cyst. The Edinburgh Ph. preparation of the tincture is to be used, and a portion is to be left in the sac, the amount used being proportioned to the size of the sac.

Where the cyst is small, where it readily slips away from the fingers, two or three silk threads, previously soaked in the tincture of iodine, may be passed through the sac, and the ends knotted so as to ensure their retention. They will usually require withdrawal at the close of twenty-four hours, signs of the approach of active inflammation being present at this time. If the inflammation be mild the seton is to be left in until the cyst feels solid. Where previous treatment has failed, where several cysts co-exist, or where the diagnosis is very obscure, an antiseptic incision is to be preferred. There is need of more caution in making this than in the case of the ordinary hydrocele, as it cannot be known beforehand whether seminal tubes are spread out over the cyst or no (p. 495). If the radical treatment of injection be adopted, it is noteworthy that these hydroceles are not so readily cured as those of the tunica vaginalis. The reason of this

is somewhat obscure, but it has been noticed by several writers. Thus Sir B. Brodie¹ states that he has never known a case in which injection succeeded. He therefore recommended the seton or laying the sac open. M. Gosselin² considers that the failure of injections in these cases may be accounted for by the fact that the inner surface of the cyst, not being serous, is not as ready as the tunica vaginalis to become obliterated through adhesive inflammation. Probably the thinness of the walls and their slighter vascularity explain the above fact. If a seminal duct open into one of these hydroceles, and the degree of inflammation excited by injection be slight; the continuous entrance of spermatozoa may readily keep up the effusion of fluid.

One case has come under my hands in which the injection with iodine has failed; in this case antiseptic incision was followed by obliteration of the sac. In most cases the use of the seton or an antiseptic incision appears to me the best mode of radically curing these hydroceles; but it is noteworthy that Mr. Curling³ has found iodine injections satisfactory.

HYDROCELE OF THE SPERMATIC CORD.

The cord is the seat of two varieties of hydrocele—(i.) Diffuse or infiltrated hydrocele of the cord, an oedematous affection implicating the areolar tissue which unites the different constituents of the spermatic cord. (ii.) Encysted hydrocele of the cord, in which the collection of fluid is contained in a definite cyst or cavity.

(i.) *Diffuse or infiltrated hydrocele of the cord.*—The spermatic cord is enveloped by a loose layer of connective tissue which unites its several constituents, and is continuous above with the sheaths of the abdominal muscles, while below it may be traced over the epididymis and testis continuous with the subserous connective tissue beneath the tunica vaginalis. The cremaster muscle is spread out upon its outer surface. This connective tissue, which is described by some anatomists as a separate fascia, the tunica vaginalis communis, becomes occasionally the seat of a diffuse serous infiltration. This is probably of the nature of an oedema, but its causes are obscure. This connective tissue is very rich in lymphatics and small veins, and probably any obstruction from pressure above within the abdomen will produce the diffuse hydrocele. Mr. Curling⁴ suggests that enlargement of the lymphatic glands which lie in the course of the cord would produce a similar result. It is, however, a very rare affection.⁵

Symptoms.—The swelling is uniform, cylindrical, or pyriform, with the large end downward, from the fluid gravitating below into the lowest cellular tissue, the meshes of which tend, from pressure, to run into each other. The smoothness and uniformity of outline are due to the fluid being bound down by the above tunica vaginalis communis. The cord is distinctly larger than usual, and feels somewhat like a varicocele or omental hernia. The testis and epididymis below are normal. There is no pain, but discomfort from the dragging weight is felt above in the loin. By gentle and continued pressure the swelling can be made to recede, but it returns immediately when the pressure is removed, and that as readily when the patient is lying down as when he is erect.

Diagnosis.—An omental hernia is the condition which is most likely to be mistaken for diffuse hydrocele of the cord. Both extend upwards along the cord into the canal; both feel somewhat dense, but little yielding to pressure; and neither is sensitive to handling. The points of distinction are chiefly—the hernia shows a better marked impulse when the patient coughs; it can be more completely and easily returned; and it feels granular or lobulated on careful examination, instead of being uniform. After its return, the cord and external abdominal ring can be more

¹ *Med. Gaz.* vol. xiii. p. 139. It will be remembered that Sir B. Brodie used wine, and not iodine, as an injection.

² *Loc. supra cit.* p. 180.

³ *Loc. supra cit.* p. 166.

⁴ *Loc. supra cit.* p. 169.

⁵ Mr. Pott (*Pract. Rem. on the Hydrocele, &c.*, p. 39) records three cases. See also Scarpa's *Memoria sull' Idrocele del Cordone Spermatico*.

completely made out than is the case with the hydrocele. Where, however, the omental hernia is irreducible, or where the subject of the hydrocele is very stout, the diagnosis will be very difficult, and can only be cleared up, when necessary, by a careful incision made with antiseptic precautions.

From an encysted hydrocele the diffused form may be known by its less clearly marked and less rounded outline, its extension upwards, and the alteration produced in it by careful kneading pressure.

Treatment.—Owing to the large size to which this form of hydrocele may attain, and its tendency to re-collect after tapping or acupuncture, radical treatment will sometimes be called for. In such cases the situation of the fluid, as has been already mentioned (p. 500), in connective tissue very rich in lymphatics, must be remembered, on account of the tendency of operative interference to set up diffuse inflammation and septicæmia. Mr. Pott,¹ in a case where, after tapping and withdrawal of eleven Winchester pints of fluid, the fluid had re-collected, divided the hydrocele very freely. 'The discharge of water continued large, the wound neither inflamed nor digested, nor, on the other hand, did it wear any face of gangrene or mortification; but his languor and anxiety increasing hourly, and his wound remaining in the same unaltered state, on the fourteenth day from the last operation he died.' In this case Mr. Pott attributed the fatal result to the large discharge of serum rather than to the free division 'of membranous parts.' Thus he adds that the patient's 'manner of dying was very much like that of those who are destroyed by large hæmorrhages.'

Where radical treatment is really called for, acupuncture or tapping having failed, and all possible causes of this condition having been removed, antiseptic incision of the swelling followed by careful support to the scrotum and inguinal canal with a spica bandage will be the wisest treatment.

(ii.) *Encysted hydrocele of the cord.*—Here the fluid, instead of being infiltrated or diffused through the connective tissue of the cord, is contained in a distinct cavity or cyst. This may originate in different ways: (a) most frequently, and thus corresponding to the age at which it is most often met with, viz. in childhood, from some unobliterated portion of the processus funicularis. The frequency with which this deficiency persists has already been alluded to (p. 490) under the head of congenital hydrocele. According to Prof. Engel,² obliteration takes place earlier on the left side than on the right; this more frequent persistence of patency on the right side thus accounting for the greater frequency of right-sided congenital hernia, congenital hydrocele, and of encysted hydrocele also. From this imperfect obliteration of a process of serous membrane result one or more persistent sacs, which may easily become distended with serum. (β) More rarely, in some cysts of new formation and independently of any abnormal persistence of the processus funicularis. This may occur after a strain from extravasation into the cellular tissue of the cord, the fluid part of the blood becoming encysted, and its colouring matter absorbed. (γ) Mr. Curling points out that it is possible that the organ of Giralde's may occasionally form an encysted hydrocele of the cord, but that this remains so minute as to be rarely perceptible. The relation of this body to encysted hydroceles has, owing to its constant position just above the epididymis, been already discussed under the head of encysted hydrocele of the epididymis (p. 496).

Symptoms.—Encysted hydrocele of the cord is usually met with as a defined single swelling, often somewhat oval in shape, translucent, painless, and freely movable. The defined tense outline is due to the cyst being beneath the investing cellular sheath of the cord, the so-called tunica communis, of which mention has been already made; and its being beneath this also explains the indistinctness of the fluctuation which is usually met with. When more than one cyst is present, their origin in the persistent processus funicularis is almost certain. The size is usually small, rarely exceeding that of a walnut or bantam's egg. The cyst may be met with at any part within the inguinal canal, immediately above the testis, or between the two. Most frequently it occurs in the middle portion, just below the external

¹ *Loc. supra cit.* p. 46.

² *Wien. Woch.* 1858, and p. 490.

abdominal ring. The onset and progress of these cysts are usually extremely slow. When there is a reliable history of their making their appearance suddenly, it is probable that effusion, of a more or less inflammatory nature, has taken place into an unobliterated and hitherto latent portion of the processus funicularis.

Diagnosis.—Children, the subjects of encysted hydrocele of the cord, are frequently brought to the surgeon in the belief that they are suffering from hernia. It is when the cyst lies within the inguinal canal that some difficulty will be met with in distinguishing it from a bubonocoele, especially when the soft parts are fat, and the patient a little child. Attention should be paid to the following points. When the cyst is below the external abdominal ring impulse will be absent; when it is within the inguinal canal it will be much less distinct than in the case of a bubonocoele, this indistinctness being increased by drawing down the cyst. It can be pushed upwards, but not returned completely; returning readily, whatever be the position of the patient, and emitting no gurgling, when manipulated. Translucency can nearly always be made out, though in fat and young children this is often a matter of difficulty. Finally, the defined shape and size of the cyst, together with the absence of any neck, are to be remembered.

The following case of an encysted hydrocele which would pass through the external abdominal ring, and which was mistaken for a hernia, is a good instance of the importance of a right diagnosis in these cases.

A boy, æt. 15, had for some time worn a truss, but found it inefficient. There was an oblong swelling on the right side of the scrotum, not reaching to the bottom of it. The testis and cord were independent of the swelling. It was tenser and larger when the patient was erect; by pressure it was easily pushed up towards the external abdominal ring, and finally passed through it. It then appeared to be reduced like a common hernia, but a close examination showed it to have lodged above the ring, where it formed a distinct swelling. No pressure could carry it further into the abdomen, but on removing pressure it reappeared in the scrotum. Its parietes felt and slipped beneath the finger and thumb like a piece of intestine. Fluctuation was indistinct, and coughing imparted no impulse to the swelling, which was translucent. On opening the cyst it was found to be a quarter of an inch thick, and contained about two ounces of fluid. Considerable suppuration followed, but the patient was cured in seven weeks.

Treatment.—In children the use of evaporating lotions, or counter-irritation with Tr. Iod. or Liq. Episp., according to the age of the patient, will often be successful. If not, acupuncture may be made use of. In adults, or where acupuncture fails in children, iodine injection will usually be successful. Where the cyst is very small and mobile, and therefore difficult to inject, a small seton may be used if the cyst be below the external abdominal ring. But where the cyst is higher up and within the inguinal canal, an antiseptic incision will be found the wiser course. At this level, from the contiguity of the peritonæum, and from the numerous planes of cellular tissue in the abdominal walls, any risk of setting up diffuse inflammation is especially to be avoided, and for this reason a radical cure by means of an incision with antiseptic precautions (p. 488) is to be preferred.

COMPLICATIONS OF HYDROCELE.

A hydrocele may be complicated (α) by the coexistence of one or more hydroceles, or (β) by the presence of a hernia.

(α) *Multiple hydrocele.*—The combination of hydroceles most frequently met with is that of ordinary hydrocele of the tunica vaginalis, and encysted hydrocele of the testis. It is probable that the encysted hydrocele is formed first, and that, owing to the irritation which its presence produces, effusion of fluid takes place secondarily into the cavity of the tunica vaginalis. When the latter collection of fluid has attained a large size, the presence of an encysted hydrocele may easily be overlooked. In such cases when the tunica vaginalis is tapped the usual pale yellow fluid escapes, but the swelling, though diminished, is not removed. If now the trocar be thrust onwards into the remaining swelling the characteristic watery or opalescent fluid of encysted hydroceles escapes.

As noticed by M. Dupuytren,¹ this combination of hydroceles has sometimes been mistaken for a multilocular hydrocele.

If the above combination of hydroceles does not yield to tapping, this being effected by one or two separate punctures, it will be better to incise the swellings with antiseptic precautions. Iodine injection of the encysted or primary hydrocele would very likely cure this, and thus remove the source of irritation, but, as already mentioned, it is not uncommon to find, not one, but two or three small cysts in the neighbourhood of the epididymis, which will be most thoroughly exposed and dealt with by incision.

Another, though less common, combination of hydroceles is that of encysted hydrocele of the cord with hydrocele of the tunica vaginalis.² In this case the swellings are more distinct, and are usually separated by a furrow³ of varying width, according to the amount of funicular process of peritonæum which has been obliterated below the encysted hydrocele.

In treating this combination, acupuncture will usually suffice in childhood. Later on in life, iodine injection of both hydroceles, or, where the upper one is below the external abdominal ring, iodine injection of the lower hydrocele, while the upper one is treated by a seton (p. 499), will give good results. Where the encysted hydrocele of the cord is within the inguinal canal, radical cure by antiseptic incision is to be preferred, for reasons already given (p. 502).

The following case illustrates well some of the difficulties which will be met with in the diagnosis of some of these cases, and also how they are to be met. It was under the care of Prof. Humphry.

A youth, æt. 19, had a swelling on the right side of the scrotum, closely connected with the upper and fore part of the testicle. Fluctuation could be perceived in it, and transparency when the skin was stretched tightly over it. Above this, at the external ring, was a small soft swelling, doughy, not distinctly fluctuating. Like a hernia it went up into the abdomen, quite out of reach, when he was laid down, and returned again when he stood up or coughed. It also communicated an impulse to the finger when he coughed. He wore a truss, which had been ordered by an experienced hospital surgeon. Prof. Humphry was induced to examine more carefully by observing that the impulse was less distinct than it usually is in hernia. Moreover, when the patient stood and coughed, the swelling seemed to bolt past the finger and thumb, which, with a little pressure, met together above it; and it appeared as though it could be pressed to and fro, as though it were a distinct cyst or tumour, and not a swelling prolonged into the abdomen. When the patient was laid down, and the swelling had disappeared, it could be brought into view, and even brought beyond the external ring, by traction upon the cord. When thus pulled down, with the skin drawn tightly over it, the light of a candle could be seen through it. Prof. Humphry accordingly cut down carefully through the cremaster, which was unusually distinct, and the other coverings, and exposed a sac, in which membranous contents capable of being moved about, and having vessels upon them, could be seen. They looked and felt like omentum or intestine in a hernial sac. The candle was again used, and finding that the swelling was quite transparent, and that its contents could not be returned into the abdomen while the cord was fixed, the sac was opened, giving vent to some clear fluid, and exposing several thin-walled cysts, bearing vessels, and containing similar fluid. Some were as large as a bean, the others were smaller. They were connected together and with the upper part of the cyst, which proved to be a closed sac unconnected with the abdomen. The mass of cysts, with a portion of the containing sac, was cut away; and the lower and larger swelling, which appeared to be formed by a portion of the tunica vaginalis distended with fluid, was then opened. Suppuration ensued, the wound healed up, and the lad recovered.

(3) *Combination of hydrocele and hernia.*—A large hydrocele predisposes to hernia partly by its constant drag upon the cord and the peritonæum above, and also by its tendency to reach upwards, and thus to weaken the external abdominal ring. Thus the most frequent combination is that of hydrocele of the tunica vaginalis with inguinal or scrotal hernia. The two swellings can be usually distinguished if attention be paid separately to their chief determining points (p. 483). Thus the swelling which corresponds to the hydrocele will be dull upon percussion, translucent, irre-

¹ *Lec. or. de Clin. chir.* t. iv. p. 197.

² There is a good preparation of this in St. Thomas's Hosp. Mus. prep. E.E. 73.

³ As remarked by Mr. Curling (*loc. supra cit.* p. 187), this furrow will not be well marked in some cases, especially in the small parts of a child.

ducible smooth, and uniform in outline, and, if not very tense, giving some evidence of fluctuation. The upper one, on the other hand, will, unless entirely omental, be resonant in part, non-translucent, probably reducible to a certain amount, and with characteristic slip or gurgle; while fluctuation is entirely wanting, being replaced where omentum is present by the doughy, irregular, granular feel.

There is usually some amount of free space, or of constriction between the two swellings, especially at first. Where, however, they have lasted for some time, owing to alterations which are taking place in them—viz. thickening of the tunica vaginalis and of the hernial sac; adhesions between the hernial contents and their investing sac; atrophy of the testis, and spreading out of the constituents of the cord—the diagnosis is rendered more difficult. Furthermore, as time goes on, adhesions take place between the hernial sac and the hydrocele, which not only renders the diagnosis more difficult, but also, especially in those advanced in life, complicates the treatment.

The hydrocele is usually placed anterior to the hernia which lies towards the back of the scrotum. If, on careful examination, the hydrocele be posterior to the hernial sac, the former will usually be found to have opened up a portion of the processus funicularis.

Encysted hydrocele of the cord is occasionally complicated with inguinal hernia, As already explained (p. 501), this form of hydrocele usually depends upon imperfect obliteration of the processus funicularis. As this obliteration may take place at one or two spots, leaving one or more segments of the serous process unobliterated, and as the uppermost of these may communicate with the peritoneal cavity, and thus contain a loop of intestine, care should always be taken to exclude any complication with hernia before encysted hydrocele of the cord is submitted to a radical cure.¹

In the treatment of combined hydrocele and hernia, as long as the two swellings are distinct and the patient is not advanced in years, the hydrocele may be treated by iodine injection, the hernia being first carefully reduced. Where this preliminary step is impracticable, in cases where the hydrocele and hernia seem to be adherent to each other, and where any especial reason exists for dreading diffuse inflammation, radical cure by antiseptic incision is to be preferred to other means.

In elderly patients with voluminous herniæ, palliative treatment will be the wisest course. Tapping the hydrocele will usually allow of the proper adjustment of the truss.

HYDROCELE OF A HERNIAL SAC.

This term is used when the sac of a hernia becomes the seat of a serous effusion, after its communication with the general peritoneal cavity has been shut off by the closure of its neck by adhesions, by a portion of omentum, or by the long-continued pressure of a truss. The fluid is usually clear, straw or amber coloured, serous, and resembling that met with in hydrocele of the tunica vaginalis. Owing to the well-known extensibility of the serous sac of a hernia, large collections of fluid may be met with in these cases. Thus Mr. Langton has recorded one in which three and a half pints of fluid were evacuated.

The source of the fluid in these cases is chiefly from the vessels of the large and slowly increasing sac, owing to the obstruction which the thin-walled veins meet with at the neck of the sac from the pressure of a truss, from the presence of adhesions, &c. That the fluid is not effused from the omental vessels seems clear from the fact that in some cases where a very large collection of fluid has slowly formed in a hernial sac the neck is merely occupied by a small nodule of omentum.

¹ Mr. Rivington (*London Hosp. Reports*, vol. ii. p. 371) has recorded a case in which an encysted hydrocele of the cord on the right side was combined with an inguinal hernia on the same side. Externally the appearance of the parts was indicative merely of inguinal hernia. On dissection a hernial sac containing a reducible knuckle of small intestine was found to dip down into an encysted hydrocele of the cord. If an operation had been required for strangulation, the surgeon would have opened an apparent hernial sac containing fluid, and would then have come down upon a second swelling with a smooth serous surface, which constituted the real sac and hernial contents.

Hydrocele of the sac is much more common in inguinal than in femoral herniæ, for the same reasons that large inguinal herniæ are much more frequently met with, without strangulation, than femoral.¹

The symptoms of this affection are chiefly those of hydrocele occurring at the site of a hernia, usually inguinal, of long standing, and often with the history of a truss having been worn for many years. The swelling will be found to fluctuate, to be translucent, and when of any size to possess a distinct thrill when percussed with the finger. It encroaches somewhat upon the external abdominal ring, extending upwards higher than an ordinary hydrocele of the tunica vaginalis, but, usually, impulse on coughing is but little if at all marked.

If more than palliative treatment is required, obliteration of the sac by antiseptic incision and drainage will be the safest course.

HÆMATOCELE.

This consists in an effusion of blood, either into the cavity of the tunica vaginalis, or into a cyst connected with the testicle or the cord. The following forms of hæmatocele, therefore, present themselves for consideration :—

- i. Hæmatocele of the tunica vaginalis.
- ii. Encysted hæmatocele of the testis.
- iii. Hæmatocele of the cord.

Extravasations of blood into the scrotum and into the substance of the testis itself are also included by some writers under the term hæmatocele. The former occur usually as part of the results of a traumatic hæmatocele; the latter is alluded to at p. 512.

(i.) *Hæmatocele of the tunica vaginalis*.—This is the only common form of hæmatocele. In the great majority of cases it is traumatic in origin. In fact, by most writers this form of hæmatocele is the only one described. There appears, however, sufficient ground for believing that occasionally hæmatocele may occur without any violence.

A. Non-traumatic or spontaneous hæmatocele.—Cases will sometimes be met with where the patient is positive that he has received no injury, and that the affected side of the scrotum was natural before the onset of the hæmatocele, and where the surgeon will be able to discover no ecchymosis or trace of contusion.

Sir B. Brodie² speaks thus of these cases :—‘ At other times, but more rarely, a hæmatocele occurs without any evident cause. I suppose it is in this case to be attributed to a diseased state of the blood-vessels. Extravasation of blood within the cranium very rarely takes place independently of mechanical injury, except the blood-vessels are diseased; and the same diseased state of the vessels which makes them liable to give way in the brain, makes them liable to give way in other parts of the body. Persons who have diseased vessels frequently have extravasation of blood into the cellular membrane of the legs or thighs, forming afterwards collections of fluid resembling coffee-grounds; and it is reasonable to suppose that under the same circumstances blood may be effused from the vessels of the testicle.’

B. Traumatic.—This, the more common form of hæmatocele, presents itself under two conditions—(a) in combination with hydrocele, (β) without any such combination.

(a) *In combination with hydrocele*.—Traumatic hæmatocele of the tunica vaginalis

¹ Mr. Langton (*St. Barth. Hosp. Reports*, vol. x. p. 381) records a very interesting case of a ‘large hydrocele of the sac of a femoral hernia treated successfully with a seton and incision.’

² *Lond. Med. Gaz.* vol. xiii. p. 380. See also Dr. Packard, ‘A Case of Hæmatocele,’ *Am. Journ. Med. Sci.* 1858, vol. ii. p. 83; Nélaton, *Clin. Lect. on Surgery*, reported by Dr. Attlee, p. 653. Dr. Svalin (*Hygiea, Août 1845*) records a case of ‘hématocele spontané.’ A man, æt. 45, coughing violently while at stool, ‘éprouva une sensation comme si quelque-chose tombait brusquement dans le scrotum.’ The left side of the scrotum became immediately swollen, bluish, and painful. Upon incision, a large ecchymosis was found in the scrotum, and a clot the size of two eggs in the tunica vaginalis. A vessel which was seen to be bleeding near the head of the epididymis was ligatured, and the case did well.

occurs not unfrequently in combination with a hydrocele, and that in two ways. It may occur after tapping a hydrocele. This may be occasioned by the puncture of a small vessel on the parietal portion of the tunica vaginalis which happens to lie in the way of the trocar. It is especially likely to follow on the use of a lancet or a needlessly large trocar, or if any hitch is met with on introducing the trocar owing to the shoulder of the cannula not fitting well, or to the patient's making a sudden move. Under the latter circumstances a sudden plunge or darting forwards of the trocar is only too probable, resulting in a puncture of the testis or of the opposite surface of the tunica vaginalis. The nature of the accident may be sometimes recognised by the escape of blood which takes place from the cannula on the withdrawal of the trocar, by which the hydrocele fluid is more or less deeply tinged. But more often no untoward symptom is noticed at the time, the side of the scrotum which corresponded to the hydrocele being found to become larger within an interval which varies considerably according to the rate at which the blood escapes, the movements of the patient, &c.

In a few cases a hæmatocele of the tunica vaginalis may occur after tapping, but not in consequence of this save indirectly. This extravasation of blood from

FIG. 102.—Laminated Coagula in a large Hæmatocele. (Guy's Hosp. Mus., Prep. 2384.¹)



weakened and varicose vessels of the tunica vaginalis may follow on withdrawal of the hydrocele fluid which has previously afforded these weakened vessels support.

A hæmatocele may occur in combination with a hydrocele in another way, but entirely independently of any tapping. Owing to the distention of the tunica vaginalis with fluid it becomes more voluminous, more resisting, less movable, and therefore less able to evade external violence and injury. In such cases a patient may have his hydrocele converted into a hæmatocele by a blow against the pommel of a saddle, or by falling against a chair.

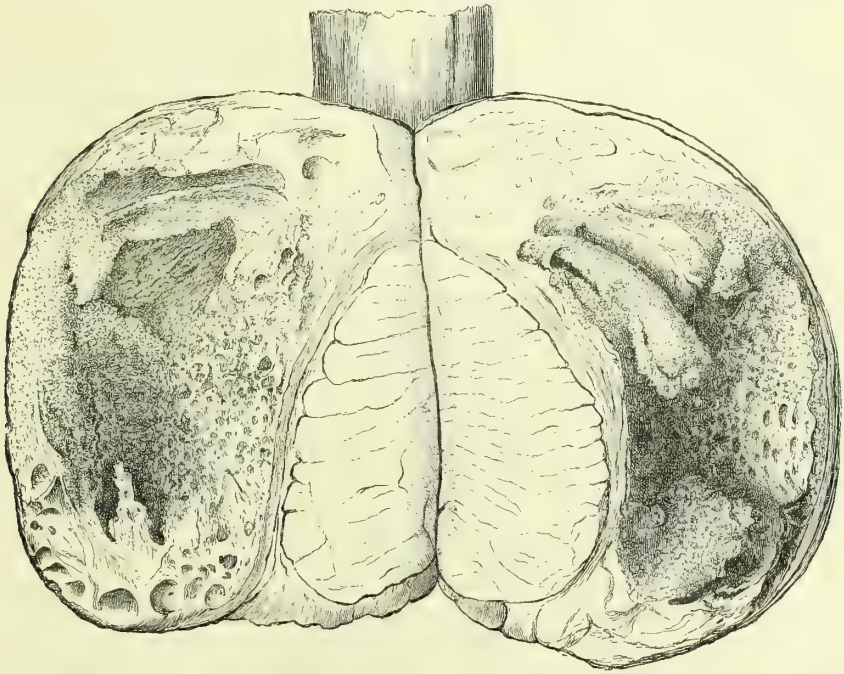
(β) *Without any combination with a hydrocele.*—This is a rarer form of traumatic hæmatocele, owing to the natural mobility of the testis. It occurs after making straining efforts, as in lifting heavy weights, or when the testis is struck against the pommel of a saddle. I have seen one case in which the patient, who was working in the Woolwich Arsenal, received a blow from a slowly moving piece of metal; this produced an enormous hæmatocele on the left side, both extra- and intra-vaginal. The patient, a healthy man of middle age, recovered well with palliative treatment.

¹ There is, unfortunately, no history of this preparation.

The fluid of hæmatoceles.—The quantity of the blood in hæmatocele varies very much. Sometimes, when it occurs after a strain, from weakened or degenerated vessels, or after tapping, it may be small in amount; in the latter case there may sometimes seem a large amount of blood, when in reality the fluid is only tinged, subsequent tapping drawing off the usual clear hydrocele fluid. But in other cases, when it occurs after a severe blow, in a strong plethoric patient, when immediate rest is not taken, the quantity may be very large. In such cases not only is a vessel ruptured in the tunica vaginalis, but a small rent has probably taken place in the membrane itself.

The condition of the blood is also various. Sometimes it is fluid, without clots, red, chocolate-brown, and occasionally, in very long-standing cases, of thick and syrupy consistence, like treacle. In these cases, where fluid of this kind is present in a much thickened sac, the diagnosis is of the greatest difficulty. More frequently, in addition to a liquid which is more or less fluid, clots are present. These are met

FIG. 103.—A Hæmatocele laid open, showing a blood-clot firm in its outermost, and granular in its central part. (St. Barth. Hosp. Mus. Ser. xxxvi. Prep. 2744.)



with in different forms. Where the blood has escaped slowly into a sac of the tunica vaginalis which is empty, *i.e.* not occupied by hydrocele fluid, complete coagulation may take place, the clot being laminated (fig. 102), and decolorised at different parts to a varying degree; the outermost parts being firm, and fibrous and paler, while the more central parts are softer, more granular, and of darker tint, the one recalling the 'active,' and the other the 'passive' clot of M. Broca. In another class of cases, where the effusion of blood has been more rapid, the blood-clot is softer, more pliable, and devoid of lamination, altogether more of the passive kind, as in fig. 103. When the effusion of blood takes place into the cavity of a tunica vaginalis which is already occupied by a hydrocele, the fluid is often clear and red, with large masses of fresh clot floating in it.

Masses of coagula which at first have been red in colour, later on become yellow, or more completely decolorised, and line the inner surface of the parietal tunica vaginalis with an irregular layer. At another spot these clots are caverned out into honeycomb-like spaces, which are filled with reddish serous fluid (fig. 102).

The walls of hæmatoceles.—These are constituted by the tunica vaginalis coated

with false membranes of varying thickness. These false membranes are always of greater thickness over the parietal than the visceral layer of the tunica vaginalis; sometimes they are entirely absent over the testis and epididymis. At first thin and supple, easily detached with the finger-nail, these false membranes later on become denser, more resisting and inflexible, infiltrated with calcareous deposit, and utterly incapable of any retraction when incised. Their colour corresponds in tint to that of the contained fluid, being reddish, brown, or even black.

The consistence and thickness of these false membranes is a matter of considerable importance, as will be seen below from their influence upon the treatment of hæmatoceles.

It has been much discussed as to what is the real relation between the blood and the false membranes of a hæmatocele. By most writers it has been held that it is the effusion of blood which leads to inflammation of the sac, and its becoming thickened with false membranes. No doubt this is the correct sequence of events in those cases where after distinct violence a hæmatocele occurs suddenly in the normal tunica vaginalis of a healthy and comparatively young subject, who has not been previously the subject of any disease likely to bring about alterations in the tunica vaginalis, such as hydrocele, or inflammation of the testis or epididymis.

M. Gosselin¹ has brought forward an entirely different view, which he believes to be applicable to the majority of cases. He considers that effusion of blood is not the first step; that the tunica vaginalis is not normal to begin with in these cases, but that before the onset of the hæmatocele it is the seat of false membranes. In other words, it is these false membranes, and the previous inflammation of the tunica vaginalis, which produce the effusion of blood, and not *vice versâ*.

M. Gosselin bases this view on the fact, of which mention has been already made, that it is very rare to find in any subject, at all advanced in life, a tunica vaginalis without some partial adhesions or thin false membranes. In support of this belief that slight, and at the time often unperceived, inflammation is the first step in the formation of a hæmatocele, by the false membranes which it produces, M. Gosselin alludes to the great frequency with which similar results are met with in other serous membranes, *e.g.* pleura, peritonæum, and pericardium. Now the tunica vaginalis is the least protected of all the serous membranes; it is most exposed to friction, blows, squeezes, and thus is especially liable to inflammation. Inflammation of the tunica vaginalis, and the consequent production of false membranes, has perhaps been less observed here than in the case of the other serous membranes, owing to the fact that the much smaller extent of this serous membrane, and its not being in relation with any vital organ, renders inflammation of it a matter of much less gravity. M. Gosselin considers that the starting-point of the false membranes is a slow and insidious inflammation leading to exudation of plastic material, the nature of the liquid being secondary and accessory. It will remain serous, and of a more or less pronounced yellow tint, if the vascularisation is not very abundant, more deeply blood-stained when the false membrane is more distinctly vascular, the vessels of false membranes in an early stage of their organisation being abundantly provided with thin and delicate walls.

Amongst the causes of the pseudo-membranous thickening must be included everything which can give rise to a chronic and insidious inflammation of the tunica vaginalis. Sometimes the disease arises spontaneously, at another time it owns an internal cause, such as a chronic orchitis or epididymitis; sometimes the injection of a hydrocele which has not set up adhesive inflammation, or a violent contusion, or a slight one often repeated, as in riding, is the starting-point.

Site and condition of the testis.—The testis is usually at the posterior and lower part of the hæmatocele. Owing to the absence of translucency its position is best made out by pressure, which will usually detect the characteristic sensibility of this organ. But where, in addition to much blood, the tunica vaginalis is extremely thickened, where the whole swelling is tender and inflamed, or the patient timid and nervous,

¹ *Arch. gén. de Méd.* 1851, t. xxvii. pp. 5 and 295.

the position of the testis is only to be determined in the course of an incision carefully and slowly made.

The testis remains healthy in structure (fig. 103), and but little diminished in size, even in large hæmatoceles. It is in long-standing hæmatoceles which have been subject to much inflammation, and in which the tunica vaginalis and tunica albuginea are much altered, that the testis undergoes fatty and fibrous degeneration. Sir B. Brodie¹ mentions the case of an old hæmatocele in which the testis had almost entirely disappeared.

Symptoms.—The onset of these, viz. the pyriform, heavy swelling, frequently accompanied by ecchymosis of the scrotum, is usually described as being acute. But this in reality varies a good deal. In many cases where there has been a blow or strain the enlargement of the affected side of the scrotum into a pyriform, tense, indistinctly fluctuating swelling is rapid, and accompanied with discoloration of the scrotum from ecchymosis or suggillation, the patient being conscious of a sensation of rapidly increasing tension. These symptoms will be most marked in the plethoric, and after an injury which is likely to set up rapid inflammation of the part. In such a case, especially where the patient has lived recklessly, and been addicted to excessive drinking, the above symptoms may be quickly followed by suppuration and sloughing; the scrotum, at first purplish and cold to the touch, becomes red and hot, then oedematous and dusky.

The hæmatocele which occurs on the tapping of a hydrocele has already been alluded to. Here the swelling quickly returns, but is heavier, fluctuates less distinctly, and is accompanied by more discomfort or even pain. In yet another class of cases the onset of the hæmatocele is very slow and insidious, suggesting either a spontaneous origin (p. 505), or the gradual conversion of a hydrocele into a hæmatocele by small repeated bleedings into the cavity of the tunica vaginalis.

Diagnosis.—It is sometimes a matter of difficulty to distinguish an old hæmatocele, which commenced insidiously, and which now presents much thickened walls, and slight, if any, fluctuation, owing to its thick grumous contents, from an irreducible inguinal hernia. In the hæmatocele, unless it extend unusually far upwards, impulse will be entirely absent, and the cord will be more defined; the patient may, perhaps, have noticed distinctly its commencement below, and, in the case of a hernia, reduction will have been possible at an earlier date.

From a hydrocele, a hæmatocele may usually be distinguished by its absence of transparency. As this sign may be wanting in certain hydroceles (p. 482), the surgeon will also pay attention to the degree of fluctuation, the weight of the swelling, and the history of the case. As a rule, fluctuation will be more marked in the hydrocele, while the hæmatocele will be heavier. The case recorded on p. 484 will suffice to show how difficult the diagnosis is, occasionally, where an old hydrocele is heavy, feels solid, where fluctuation is indistinct, and transparency entirely wanting.

Though fluctuation is extremely obscure in a large number of old hæmatoceles, yet these are rarely so uniformly firm and solid as in orchitis, the clot or thickened contents of a hæmatocele usually yielding to firm digital pressure. But as both may date back to an injury, as both are deficient in transparency, and as some cases of orchitis are accompanied by hydrocele and alterations in the tunica vaginalis, the diagnosis must occasionally be most obscure, till an exploratory incision makes the case clear.

More frequently it is certain solid enlargements of the testis, such as old orchitis, cystic and malignant disease, which are most liable to be confused with old hæmatoceles, when the latter come under notice with much thickened walls, solid contents, and deficient history.

In many of these cases an exploratory puncture or incision is the only really reliable means of obtaining a diagnosis; the latter made carefully down to the tunica vaginalis, and carried out with antiseptic precautions, is in every case to be preferred to a puncture, as being safer and less liable to injure the testis, and likely to give more information.

¹ *Lond. Med. Gaz.* vol. xiii. p. 380.

The records of surgery contain numerous instances of mistake under able hands—hæmatocele removed for malignant disease, and malignant testes opened for hæmatocele, &c. Assistance may be derived from observing carefully the rate of increase from time to time. In cancer it usually goes on steadily, but in hæmatocele it is often irregular. Sometimes the hæmatocele ceases to enlarge, or even diminishes in size; and this seldom or never takes place in cancer.

Other points which may help are the greater weight¹ and irregularity usually met with in a new growth of the testis; thus not only does the latter often present on manipulation a bossy outline, but also a sensation that varies at different spots, viz. firmness at one place, fluctuation or a pulpy feel at another. Pain is a more marked symptom in new growths, being more usually dull and aching than the so-called characteristic 'lancinating' suffering. Testicular sensation is more completely lost in new growths, and in these implication of the cord and of the lumbar glands will often be present. Finally, puncture of a carcinoma usually gives vent to blood-stained fluid which is not large in amount, or to sero-mucous fluid which is not blood-stained. On puncture of a hæmatocele there usually escapes either grumous, altered blood, or fluid blood which flows for some time, and produces a distinct alteration in the size of the swelling.

Treatment.—This will vary according to the date at which the hæmatocele is first seen, the acuteness of its symptoms, and the probable condition of its contents and lining wall.

When the case is seen early, where it depends on some strain or injury, and where the effusion of blood is not extreme, the absorption of the latter may be expected, the process occupying perhaps a long time, and being marked by the same stages as when blood is effused in other parts. The patient should be kept lying down, with the scrotum supported on a small pillow or sand-bag, and a small ice-bag applied over a layer of lint. This is likely to be much more efficacious than a cooling lotion, which requires frequent renewal; but in elderly people, and in cases where the tension of the effused blood already interferes with the blood supply of the scrotum, the continued use of ice requires careful watching. A purge should also be given, and its action gently kept up by small doses of magnesia sulphate, &c., and the patient's diet should be restricted though nutritious. Where this treatment after a week or two has no effect, or where the amount of blood effused is, from the first, very large, where the inflammation set up by the injury threatens to run high, it will be well to tap the scrotum with a full-sized trocar, in the hope of promoting absorption by relieving the tension. To avoid the entrance of air, the fluid should not be completely withdrawn. A continuance of the rest and antiphlogistic treatment should be insisted upon. When all pain, tenderness, and redness have disappeared, if the swelling subsides steadily the patient may be allowed to go about, with the scrotum supported and strapped.

In cases where after one tapping absorption takes place to a certain amount and then remains stationary, the tunica vaginalis still containing fluid blood, the puncture may be repeated. So, too, in the case of hæmatocele occurring after hydrocele, the fluid is often noticed after repeated puncture to be again serous. In this case and in the last, after one or more tapplings, iodine injection may be made use of to complete the cure.

But where after duly attempted absorption there is a persistent collection, which not only contains fluid but also coagulated blood; where inflammation threatens to run high, and suppuration may be expected; in every case where rigors, œdema, and throbbing pain make it probable that pus is actually present, an incision is to be made with antiseptic precautions into the anterior part of the scrotum. This is to be most carefully divided, the tunica vaginalis opened on a director, and the sac emptied of all fluid or clotted blood; a drainage tube should be then inserted, a counter opening being made if necessary. If much oozing take place from many points, not admitting of torsion or ligature, the cavity of the tunica vaginalis must be lightly stuffed

¹ The subject of the value of weight in the diagnosis of tumours of the testicle is again referred to in a footnote, p. 545.

with strips of carbolised gauze, and the scrotum elevated, careful pressure being applied by means of the dressing.

This method is so safe that it is strongly recommended, not only in the above-mentioned cases, but also as preferable to repeated tapping in any cases where absorption of a fluid hæmatocele is long delayed. While it must be allowed that it gives the trouble of subsequent dressings, yet, on the other hand, repeated tappings are not devoid of the risk of setting up inflammation, a risk which is always to be avoided in hæmatocele.

Where the surgeon is compelled to lay open a hæmatocele, and is unable to adopt strict antiseptic precautions, he should brush over the interior of the cavity with a solution of zinc chloride (gr. x.—℥j.) ; or better, dust it over with powdered iodoform, while stringent precautions are taken for securing adequate drainage and facilities for washing out the cavity.

In a few cases of very long standing, in patients advanced in years or broken down in health, where the tunica vaginalis is much thickened or extensively calcareous, castration will be found to exert a less call upon the patient's powers than a free incision. But when carried out with antiseptic precautions, the latter will be found to be free from those dangers—viz. septicæmia from the putrescent blood-clot, erysipelas, sloughing, profuse suppuration, hectic, &c.—which have in past days made incision of a hæmatocele so frequently a serious measure.

(ii.) *Encysted hæmatocele of the testis*.—This is a rare affection, and usually arises in extravasation of blood into one of those cysts or encysted hydroceles which develop in contiguity to the epididymis. The symptoms are much the same as those of encysted hydrocele, but transparency will be wanting, and fluctuation will be, according to the condition of the contained blood, much less marked, or absent altogether. The history of an injury, often a blow or squeeze, is usually present. The affection for which it is most likely to be mistaken is hæmatocele of the tunica vaginalis. In encysted hæmatocele the position of the testis is more readily made out. It usually lies to the anterior part of the swelling ; but as in both forms of hæmatocele the walls may be extremely thickened, the diagnosis can in some cases only be cleared up by an incision, which is at once the surest means of obtaining a radical cure. The same precautions which have already been recommended should be adopted here.

(iii.) *Hæmatocele of the cord*.—As in the case of hydrocele of the cord, the effusion of blood may be met with in two forms—(a) the *diffuse*, (β) the encysted hæmatocele of the cord. But there is this distinction ; the former is the more frequently met with, which is the reverse of what is the case with hydrocele, of which the encysted form is the more common. Probably the small size and the mobility of the encysted hydrocele account for the rarity with which it is converted into a hæmatocele.

(a) *Diffused hæmatocele of the cord*.—This is due to the rupture of one of the small vessels in the cord, usually a vein, into that cellular tissue which at once ensheathes the cord and connects its various constituents. The rupture is brought about by some sudden straining or exertion. Thus Mr. Pott¹ relates three cases, in one of which 'a young fellow straining to get rid of a very hard stool, felt a sudden pain in his left groin, and found a swelling extending from thence into the scrotum.' In another case 'a labouring man, who had fallen down in the street with a load on his back, was brought into St. Bartholomew's Hospital, upon a suspicion of a rupture, he having a large swelling in his groin and scrotum, consequent immediately upon his fall.' In the third case 'a considerable swelling in the groin and upper part of the scrotum came suddenly by lifting a heavy weight.'²

¹ *On the Hydrocele*, p. 143 et seq. In the *Med. Times and Gaz.* 1853, vol. i. p. 370, a case of diffuse hæmatocele of the spermatic cord is recorded by Mr. Hanley. After a kick from a horse, a tumour the size of two fists, pyriform in shape, its neck extending into the inguinal canal, very tense, with a smooth rounded outline, and feeling equally solid all over, appeared in the left side of the groin and scrotum. It completely concealed the testis and cord. The overlying skin was distended and of a purplish-red hue. The absorption of the blood took place very slowly, it being six weeks before it was sufficiently accomplished to allow of the patient's being discharged. Even then the cord remained thickened.

² In the *Med. Times and Gaz.* 1858, vol. ii. p. 413, a case is recorded in which the extravasation took place on the left side during the act of copulation.

The only case I have seen was produced in an entirely different way by the efforts of a patient to reduce a large inguinal and scrotal hernia, which had existed for some time, and was now strangulated. Here, as in a combined parietal and vaginal hæmatocele, the overlying tissues and the cellular meshes of the cord itself were loaded with dark coagulated blood, from a point above the external abdominal ring down to the scrotum. The case did well, but very tediously, owing to the entire absence of any primary union in the damaged tissues.

The sudden formation, after strain, of a swelling which occupies the lower part of the inguinal and the scrotal regions, the consequent obscuration of the cord, and, possibly, the resemblance of the feel of the extravasated blood to the omentum, may at first sight lead to the suspicion of a hernia; but the fruitlessness of all efforts at reduction, with the entire absence of any symptoms indicating an irreducible or strangulated condition of the intestine, will serve to prevent an erroneous diagnosis.

The treatment at first should be directed to preventing the onset of inflammation, and promoting the process of absorption. As a rule, owing to the richness of the cellular tissue in lymphatics, absorption will take place. In addition to the treatment already given (p. 510) flying blisters and counter-irritation may be made use of in the later stages, instead of strapping, which cannot be so well applied here.

Where this treatment fails an incision with antiseptic precautions is to be made use of; and as, if absorption does not take place, these hæmatoceles may, owing to the looseness of the cellular tissue, attain an enormous size, this step should not be delayed after a fair trial of palliative treatment.

(*β*) *Encysted hæmatocele of the cord*.—This condition is very rare. It may follow on an injury to an encysted hydrocele, or a separate small extravasation into the cord, which has become encysted. Of the former kind there is a good specimen in the Hunterian Museum (No. 2460 . . .). Here the cyst, lined by a polished membrane, is filled with soft, partly decolorised blood-clot, similar to that represented in fig. 103. There is a hernia above the hæmatocele, and a hydrocele below, an arrangement which suggests the origin of all three conditions in imperfect obliteration of the vaginal and funicular processes of the peritonæum.

The diagnosis must, in any case, be a matter of difficulty. The history of a previous swelling which has latterly been noticed to become larger and more solid, and perhaps more painful after an injury, will be the most important points to go by.

The treatment is an incision made with antiseptic precautions, and freely opening the sac. Where the latter is of any size, due arrangements should always be made for drainage.

Before leaving the subject of hæmatocele, one other variety, which has been but little described by English surgeons, should be alluded to.

Parenchymatous hæmatocele—or an extravasation of blood into the substance of the testicle itself—may occur, usually in combination with a hæmatocele of the tunica vaginalis after an injury, especially one in which the testicle, in spite of its mobility, does not escape from contusion or squeezing. Probably the coexistent hæmorrhage in the walls of the scrotum, and within the cavity of the tunica vaginalis, masks the extravasation which takes place within the substance of the testicle to a varying degree.

M. Béraud,¹ in some observations on this form of hæmatocele, points out that the arrangement of the vessels in a close network on the inner surface of the tunica albuginea tends to favour the production of this form of hæmatocele.

Two cases are recorded which were under the care of MM. Petit and Giralès. The symptoms appear to have been—pain, very acute at the time of the injury, persisting for some time afterwards. After the hæmatocele, which is usually present at the same time, has been incised, the testicle remains swollen and somewhat hard; after a while the testis presents itself at the orifice of the incision into the tunica vaginalis, and the tunica albuginea giving way, a black or dark brown protrusion is seen, which is made up of seminal tubules and clotted blood.

¹ *Arch. gén. de Méd.* 4^e Sér. t. xxv. p. 281.

Where there seems reason to suspect this condition every care should be taken, by absolute rest, elevated support, and the other steps already given (p. 510) to promote absorption of the blood. The same is to be persevered with, together with scrupulous cleanness in the dressings, if the testis projects after incising the vaginal hæmatocele. If one part of it feel softer and fluctuating a small incision may be made use of. The patient should be prepared to expect an altered condition of the testis, *i.e.* a permanent degree of hardness or diminution of size.

FIBROUS AND CARTILAGINOUS BODIES, ATTACHED OR FREE, IN THE CAVITY OF THE TUNICA VAGINALIS.

Projections, varying in size and structure, being sometimes cystic, and at others solid, are not unfrequently found on the visceral surface of the tunica vaginalis.

These come under two main heads—(1) A more irregular variety of projections, usually small and solid, or wart-like, sometimes more leaflike (fig. 104) and pendulous. These may be found, like the projections to be next described, near the upper junction of the testis and epididymis, and may then originate in the same way; but they are also found irregularly scattered over the visceral tunica vaginalis, and in these latter cases originate, not in relics of certain definite fetal structures, but in previous inflammation starting from without, or from the subjacent testis and epididymis, and in either case are insidious and unnoticed by the patient.

(2) A more regular and constant projection is that which is nearly always to be found between the globus major of the epididymis and the body of the testis. It lies between the visceral layer of the tunica vaginalis and the tunica albuginea, is usually ovoid or round, but most frequently pyriform in shape, sometimes sessile, but more often pedunculated. Its name, 'Hydatid of Morgagni,'¹ was given to it by this most careful observer, the term 'hydatid' not here referring to any connection with an entozoon, but being merely used as synonymous with vesicle. More recently it has been proved to originate in an unobliterated relic of the Müllerian duct (p. 496), and its connection with encysted hydrocele of the testis has already been considered.

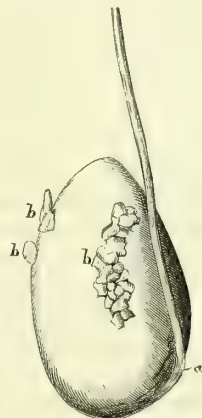
Occasionally this or any other projection on the tunica vaginalis may, when pedunculated (and the hydatid of Morgagni may have a peduncle almost an inch in length), be a source of irritation to the tunica vaginalis, and cause the gradual appearance of a hydrocele, much in the same way as a pedunculated and semi-solid synovial fringe may set up an irritative synovitis.

Occasionally fibrous or fibro-cartilaginous bodies are met with not attached, as above, but loose and free in the cavity of the tunica vaginalis. They are commonly spherical, or nearly so, and are composed of laminæ of toughish fibrous, or fibro-cartilaginous, structure, with earthy matter at the middle. Probably they originate sometimes in the small fibrous processes just mentioned, or in cysts developed in them. These, increasing in size, becoming pedunculated, and then detached by giving way of the pedicle, and solidifying, might give rise to the bodies in question. This view derives confirmation from a case examined by Duplay;² one cartilaginous body was loose in

¹ *Seats and Causes of Diseases*, Letters 4 and 43. See also Mr. Osborn's paper, *St. Thomas's Hosp. Reports*, vol. v. p. 81, 'On the Corpus Morgagni with reference to the Diseases of the Testicle,' and Sir A. Cooper, *loc. supra cit.* p. 204.

² *Archives générales de Médecine*, 1855, vol. ii. p. 133. In the Museum at Fort Pitt, Chatham, is 'a small pedunculated body of an ossific nature attached to the vaginal tunic covering the globus minor.' In pl. xiii. fig. 2 of Sir A. Cooper's work, a cartilaginous body is represented hanging from the caput epididymis by its pedicle. Sir A. Cooper has also seen one of these little bodies pendulous from the internal surface of a cyst between the tunica vaginalis and the tunica albuginea. He never detected them in the living body.

FIG. 104. — Hydrocele with Pouch-like Projections (*b, b, b,*) of the Tunica Vaginalis; *a*, testicle and vas deferens. (Path. Mus. Univ. Camb.)



the cavity, and another was attached by a filiform pedicle to the head of the epididymis. They are sometimes found in hydroceles.

In a patient who used to suffer excessive pain as soon as the operation of drawing off the fluid was over, lying down on the floor and groaning with agony for a quarter of an hour, Sir B. Brodie¹ found a loose cartilage after death in the cavity of the tunica vaginalis.

They may be recognised during life, and removed by an antiseptic incision if they are a source of annoyance. Often they do not attract attention, and are discovered accidentally.

Lately, in examining the hydrocele of a man aged about 50, which had recently been tapped, and which was rather flaccid from the fluid not having fully re-accumulated, Prof. Humphry felt a firm smooth body slipping about in the cavity. A small incision was made, and a disc extracted as large as a bean, polished on the exterior, and composed of compact fibrous layers encircling an earthy nucleus. Hæmatocele ensued with intense pain, rendering it necessary to lay open the cavity fully. This hydrocele was of six months' duration, and had been twice tapped without there being any unusual pain or other symptom indicating the presence of a foreign body.

INFLAMMATION OF THE TESTICLE.

This may be of two distinct kinds, accordingly as the inflammation starts in the testis itself or in the epididymis; it being distinctly understood that inflammatory changes which commence in the one may after a while invade the other, this being especially common in the case of inflammation of the epididymis. Either orchitis or epididymitis may be acute, sub-acute, or chronic. Two common varieties of chronic inflammation of the testis and epididymis, viz. syphilitic orchitis and the so-called tubercular or scrofulous testis, will be described separately.

INFLAMMATION OF THE TESTIS ITSELF, OR ORCHITIS.

This may be acute, sub-acute, or chronic. Acute and sub-acute orchitis occur after injuries or contusions of the testis, in the course of certain febrile affections, and sometimes also form part of the Protean manifestations of gout and rheumatism. Chronic orchitis may occur after the acute or sub-acute varieties; very frequently it is syphilitic in origin.

Acute and sub-acute orchitis.—Acute inflammation of the testis itself, or testitis, as it might well be called, is of rare occurrence compared with epididymitis. The presence of a firm, dense, unyielding tunica albuginea, which not only surrounds the testis, but also, by means of the septa and fasciculi which are sent off from every part of its inner surface, holds the delicate structure of this organ closely together, and the mobility of the testis, are the chief explanations of the rarity of orchitis; while the greater frequency of epididymitis may be explained not so much by its greater exposure and by its lacking, save above, the protection of a tunica albuginea, but by the fact that it is in more intimate relation with the vas deferens, and thus with the urethra, and so intercepts more than one inflammation which would otherwise reach the testis.

As inflammation of the testis can be very rarely fatal, but little is known exactly of the alterations which take place in the structure of the organ. MM. Monod and Terrillon² have described the following appearances as frequently met with after experimental contusion of the testicles in dogs, grouped according to the severity of the lesion. In contusions of the first and slightest degree of severity, capillary hæmorrhages of varying number were scattered throughout the intertubular connective tissue, this tissue becoming œdematous and loaded with inflammatory products. After severer contusions small masses are found, varying in size from that of a pea to a cherry-stone, and consisting of hæmorrhage mingled with the debris of lacerated tubes. Still greater violence may be followed by rupture of the tunica albuginea and actual crushing of the testis structure. The hæmorrhage which follows on the rupture of the tunica albuginea from the network of vessels which lies beneath it usually causes in these cases a hæmatocele of the tunica vaginalis.

¹ *Lond. Med. Gaz.* vol. xiii. ² *Archiv. gén. de Méd.* 1881, tom. ii. pp. 461, 567, 692.

The results of acute orchitis are as follows :—(1) *Resolution*, and return of the gland into its healthy state, this being the commonest of all. (2) *Suppuration*. This is extremely rare, since, owing to the remarkable development of the lymphatics of the testis, and their origin in wide lacunar passages between the seminal tubes, the results of inflammation, unless pus has accumulated in large quantity, are easily absorbed. When inflammation of the testis terminates in suppuration, and the pus is not absorbed, it may occasionally make its exit by means of a fistulous opening, after which a cure takes place, though the testis remains smaller and harder than usual. Owing to the resistance of the tunica albuginea, the pus may make its exit by several fistulæ, damaging the testis irreparably. In other cases it remains encysted, and the purulent collection never coming to the surface, but gradually becoming solidified and even cretified, either remains indolent indefinitely, or like an abscess shut in by bone, is the seat of chronic pain, and renders the patient liable to repeated outbreaks of inflammation. Such a collection of concrete pus may be distinguished from tubercle by the fact that it possesses a distinct capsule, and that it affects the body of the testis, and not the epididymis, which is perhaps quite healthy. From the syphilitic gumma the collection of pus may also be known by the surrounding capsule, and by the fact that the gumma is tough and consistent, while the concrete pus is friable, and more easily miscible with water. (3) *Gangrene*. This is even rarer than suppuration, and can only occur when the inflammation has been severe and neglected, and in aged or broken-down patients.¹ (4) *Atrophy*. Next to resolution, this is the most frequent result of acute inflammation of the testis, and it is the importance of this result which makes early treatment of inflammation of the testis so important. It is more common after traumatic orchitis than after secondary, *e.g.* gonorrhæal epididymitis. In the former there is not only a cellular proliferation of the intertubular connective tissue, which tends to undergo a fibrous transformation or sclerosis, but the walls of the tubes themselves become thickened, their epithelium next undergoes a granular fatty degeneration, and the lumen is finally entirely closed. In gonorrhæal epididymitis, on the other hand, the lesions are more limited to the tubes. The inflammation here belongs to the category known as catarrhal. The epithelium is the element chiefly affected, the walls of the tubes are affected secondarily, and sclerosis of the intertubular connective tissue is more localised and patchy and less disseminated. (5) *Chronic inflammation*. This will be alluded to separately under the head of Chronic Orchitis (p. 521).

Causes of acute or sub-acute orchitis.—Of these injury is the most frequent, such as striking the testis against the pommel of a saddle in riding, or against furniture, as the patient makes his way across a dark room. Occasionally it results from cold.² In a few cases sub-acute orchitis follows upon engorgement of the testis, when extreme or prolonged sexual excitement has not been followed by gratification. By some writers it has been thought possible that in violent efforts compression of the spermatic veins by the muscular fibres which are in relation to the inguinal apertures and canal may produce orchitis by engorgement of the testis. While it is not uncommon in out-patient practice to see cases of epididymitis attributed to efforts and strains, before accepting any such cause any chronic urethritis must be most carefully excluded.³

Next to injury the most important causes of orchitis are gout, and perhaps rheumatism and mumps.

Gouty orchitis has been sometimes described under the head of suppressed or

¹ A case of gangrene of an inflamed undescended testis is recorded at p. 471. One of orchitis which ended in gangrene will be found in the *New York Med. Journ.* for June 1880. Here the hydrocele which accompanied the primary orchitis appears to have been converted into a hæmatocele by repeatedappings, and the gangrene to have set in from this time. The scrotum was enormously distended, and the right half was tympanitic. The testis was removed, and the patient recovered.

² Dr. Van Buren (*Surg. Dis. of Genito-Urinary Organs*, p. 412) relates a marked case of this kind, in which the orchitis was followed by atrophy.

³ M. Duplay has recorded (*Arch. gén. de Méd.* 1876, vol. ii.) ‘trois cas de prétendues orchi-épididymites par effort.’ In each of these a chronic urethritis existed, which would have escaped save for careful examination.

irregular gout; but Sir J. Paget,¹ who has given the best description of this affection, prefers to call it a form of incomplete gout—a term which implies that it occurs in persons in whom the gouty constitution, although present, is not so complete as to produce a typical form of the disease.

A gentleman had acute orchitis, attended with all the usual signs, local and general. No history of injury, no sign of renal calculus nor of one having passed through the bladder and irritating the urethra, nor of inflammation of the prostate or urethra, could be made out, and it became necessary to look for some general or constitutional cause. The patient said that he had never had any illness in his life, but mentioned that he had lately been annoyed with a pain in his heel, which did not lay him up, and that not unfrequently on awaking in the morning he felt pains darting through his knuckles, and sometimes his fingers and toes felt rather stiff. Also he frequently had cramps during the night in the muscles of the calf and elsewhere; he had suffered, too, a good deal from indigestion attended with flatulence; and lastly he had been troubled with painful erections, which often disturbed him two or three times in the night.²

Sir J. Paget goes on to remark that, though not one of these five or six things would be enough, if taken alone, to prove anything, yet their coincidence or quick succession was quite sufficient to show that the patient had a gouty constitution. Then he admitted that some of his relatives had been treated for gout, though he did not think that any had had it badly. The belief that this patient's orchitis was gouty was confirmed by the result of the treatment. Gouty orchitis, which was commonly attended with the formation of a considerable amount of fluid in the cavity of the tunica vaginalis, was very prone to relapse, and was thus often very tedious; it occurred in very sudden seizures, and not rarely it was transferred by metastasis from one testis to the other. Sir J. Paget has also pointed out another way in which gout and inflammation of the testis may be combined. 'More rarely a severe attack of gout, accompanied with sharp fever, might lead to the appearance of scrofula, just as typhoid fever might bring out well-marked scrofulous inflammation of the ribs, or scarlet fever scrofulous inflammation of the lymphatic glands or hip-joint. All these might be brought under the broad general rule that any feverish disturbance, or perhaps more exactly any degeneration produced by fever, might bring to light the constitutional disposition of the patient.'³

That form of orchitis which occurs in acute and sub-acute rheumatism has been alluded to by but few writers. After what happens with analogous structures, it is not surprising that the tunica vaginalis and tunica albuginea should be thus attacked, but, for the sake of accuracy, it will be needful when cases of this kind are recorded to distinguish them from gouty orchitis and the epididymitis which occurs with gonorrhœal rheumatism. Dr. Macleod,³ a former physician of St. George's Hospital, stated his opinion that rheumatism sometimes affects the tunica albuginea in the following words:—'Persons subject to rheumatism have complained of acute pain in one testicle, coming on suddenly, accompanied by increased heat, and by great tenderness to the touch, but without tumefaction, the symptoms shifting from one testis to the other, and at last disappearing as suddenly as they had come on, just in the manner we see rheumatism change from one joint to another.' M. Bouisson⁴ has more recently recorded cases of this kind, and Mr. Curling⁵ states that several cases of orchitis, undoubtedly rheumatic, have come under the notice of Dr. Garrod.

That form of orchitis which complicates parotitis or mumps is by no means uncommon, and has been recognised since the time of Hippocrates. It is most frequently met with about the time of puberty, or in young strong adults, very rarely in childhood or old age. It begins usually about the fifth or sixth day, and commonly in one testicle, sometimes in both. The testis itself is usually affected—i.e. the affection is a true orchitis; less frequently an acute epididymitis, with hydrocele and œdema of the scrotum, is present from the first. The affection reaches its height

¹ *Brit. Med. Journ.* 1875, vol. i. 'Three Lectures on the Surgical Aspects of Gout.'

² This symptom, which is due to gouty inflammation of the corpora cavernosa, is alluded to below, p. 589.

³ *Rheumatism in its Various Forms*, p. 21.

⁴ *Tribut à la Chirurgie*, 1861.

⁵ *Loc. supra cit.* p. 241.

in four or six days, and then gradually subsides. While it lasts the orchitis is most annoying, the dull aching pain telling very much on a patient who is already pulled down by the pain, pyrexia, and difficulty of swallowing which usually accompany an attack of parotitis.

Resolution and absorption of the effusion, which is usually serous, and very rarely purulent, is the commonest result of this orchitis, but atrophy, often markedly rapid and complete, has been met with in many cases, especially in those which have occurred in epidemics. The atrophy not only occurs rapidly, but is met with in apparently mild cases of parotitis. Instances of epidemic parotitis, followed in numerous instances by orchitis and atrophy of the testis, have been chiefly recorded by French military surgeons. Thus M. Dogny¹ records an epidemic in which, out of a garrison of 800 men, 87 were affected. Of these 87, one testis was affected in 23 and both in 4; but in all the 27 cases atrophy of the affected testicles took place. In another case, recorded by M. Lereboullet,² a young man, *æt.* 22, of robust health and possessing all the characters of virility, was attacked with mumps. The disease seemed mild, but on the fourth day, though the parotitis had not disappeared, double orchitis came on. Atrophy soon followed and advanced rapidly, and at the same time that this was noticed the sexual power and desire began to disappear, and the mammary glands, which were previously quite normal, were noticed to develop steadily.

The connection between the parotitis and orchitis in these cases is usually described as metastatic—*i.e.* the inflammation leaves one organ to attack another, the transference of the inflammation occurring usually to the testis, more rarely to the ovaries, and, still more rarely, according to some writers, to the brain. According to this view, many points appear to me impossible of explanation, more especially when the viscera which are affected by the inflammation are considered. Why, when the salivary glands are inflamed, should the inflammation be especially transferred to glands so widely remote in position and so different in structure as the testis and ovary? As the disease is usually one of puberty and early adolescence, if the breasts were first affected, the transference to the testis, considering the tenderness and enlargement of the breast and testis often present at puberty, would be intelligible; but no such sequence is constant, the breasts often escaping altogether. It appears to me much more probable that the inflammations of the salivary glands, the testis, &c., are different localised manifestations of one pyrexial condition, and liable to occur independently of each other. The following facts seem to support the above view. Orchitis has been noticed to occur epidemically, and be followed after a while by parotitis,³ thus reversing the order usually described. On one occasion the two affections have occurred simultaneously.⁴ Again, during epidemics of mumps, individuals who have shown no trace of swelling of the salivary glands have been attacked by orchitis.⁵ One most interesting case is recorded by Bluff,⁶ in which a man whose wife was suffering from parotitis was attacked with double orchitis.

Kocher,⁷ rejecting the theory of metastasis as being unintelligible, as, 'according to the old interpretation, the inflammation leaves one organ to go to another like an unclean spirit,'⁸ explains the connection between orchitis and parotitis as follows. Orchitis after mumps is a urethral orchitis, in which the inflammation extends from the urethral mucous membrane to the testis along the vas deferens. Kocher thus traces the inflammation. Beginning as a stomatitis, the inflammation soon reaches the salivary glands. It then travels along the throat to the intestinal tract, and thence after a few days by means of blood-infection a slight cystitis is set up, from which springs secondarily the inflammation of the testis. Kocher likens the above affection of mucous membranes to erysipelas. This comparison appears well grounded,

¹ *Journ. de Méd. et Chir.* 1832, tom. iii. p. 107. ² *Gaz. des Hôp.* Aug. 14, 1877.

³ Boyer, *Montpellier Journ. de Méd.* Feb. 1866, mai 1867, p. 239.

⁴ Kocher, 'Krankh. d. Hoden.' *Pitha und Billroth's Handb. d. Chir.* Bd. 3, S. 239.

⁵ Boyer, *loc. supra cit.* Kocher, *loc. supra cit.* p. 238.

⁶ *Gräfe und Walther's Journ.* Bd. 21.

⁷ Kocher, *loc. supra cit.* S. 240.

⁸ 'Einem unsauberen Geiste gleich,' *loc. supra cit.* S. 240.

and bears out the above expressed opinion that orchitis and mumps are both different localised expressions of one and the same general febrile condition ; but I cannot at all agree with the view that the affection of the testis is a urethral orchitis, *i.e.* correctly speaking, an epididymitis. It is the substance of the testis itself and not the epididymis which is, primarily at least, affected.

The supervention of orchitis has been noticed in certain other febrile affections, *e.g.* small-pox and typhoid fever, but much more by French than by English writers. Thus M. Velpeau,¹ M. Gosselin,² and especially M. Béraud,³ have spoken of a form of orchitis which is developed during small-pox. The last named writer believes, from an examination of the contents of the scrotum in eight cases after death from small-pox, that he has established the existence of two distinct lesions of the testis—viz. (α) peripheral, which may be divided into acute inflammation of the tunica vaginalis, and the formation of inflammatory deposits in the tail of the epididymis ; (β) parenchymatous, or actual orchitis. While the first two conditions are not infrequent, it appears that real orchitis during small-pox is rare, only one case being given ; and the same is Mr. Curling's⁴ opinion, from enquiry made of those who have had large experience of small-pox in London. M. Béraud, it should be added, believes that this lesion has been overlooked by most writers on small-pox owing to its comparatively slight importance. Prof. Trousseau,⁵ speaking of this form of orchitis, remarks : ' We must not restrict the terms orchitis and ovaritis to inflammation of the parenchyma of the testis or ovary, but extend it to inflammation of the tunica vaginalis, and to the folds of peritonæum which surround the ovaries. The inflammation of the serous membranes is the result of the small-pox eruption affecting them as it does the skin, although of course the appearances present in the two situations have very different characters, just as herpes on a mucous surface is very different from herpes on the skin. . . . The facts recorded by Béraud have been regarded as exceptional. Till he wrote neither my attention nor the attention of any one had been specially fixed upon this subject, but his work had scarcely been published when, within a week, I showed you two cases of variolous orchitis in my wards. Since that time we have had very many similar cases ; not because they are more common now than in Sydenham's time, but because we now look out for the affection, and have learned how to detect its presence.' Dr. Foster, of New York,⁶ considers that variolous orchitis may affect the parenchyma of the testis or its investments, or both together. ' I myself have seen it but four times in 432 cases.'

Dr. V. Hanot⁷ has collected four cases of orchitis occurring during typhoid fever. In one of these it is expressly stated that the epididymis was intact and painless, that the cord was not affected, and that none of the ordinary causes of orchitis could be made out. In the other cases these points are not sufficiently alluded to. In one the orchitis ran on into suppuration, leading to hernia testis and ending in the loss of two-thirds of the testis by the time the patient was convalescent. Liebermester alludes⁸ to the occasional supervention of orchitis during convalescence from typhoid fever, without the previous existence of gonorrhœa. All the cases which he saw ran a very mild course.

Neither of the above writers mentions the existence of delirium or excitement in these cases. It appears to me at least possible that the orchitis may have been of the traumatic kind, the injury having been unconsciously inflicted upon the testicle by the patient himself.

It appears to be a fact that at certain stations in the Mediterranean orchitis is known to follow on a fever, the nature of which is somewhat doubtful, being considered ' remittent ' by some and simple typhoid fever by others.⁹ This condition

¹ *Dict. de Méd.* tom. xxix. p. 468.

² French transl. of Mr. Curling's work, p. 278, *Bull. de la Soc. anat.* tom. xxii. p. 107.

³ *Arch. gén. de Méd.* 1859, vol. i. p. 274, ' Recherches sur l'Orchite et l'Ovarite varioleuses.'

⁴ *Loc. supra cit.* p. 242.

⁵ *Clin. Med.* (Syd. Soc. Tr.) vol. ii. p. 59.

⁶ Ziemssen's *Encycl. of Med. Suppl.* p. 120.

⁷ *Arch. gén. de Méd.* 1878, tom. ii. p. 595.

⁸ Ziemssen, *loc. supra cit.* vol. i. p. 182.

⁹ ' Orchitis as a Concomitant and Sequel of Mediterranean Fever,' by Dr. Ellis and Dr.

often occurs during convalescence, and is not infrequently accompanied by rheumatic pains in the limbs and joint-trouble. The swelling of the testis is often considerable, but yields to appropriate treatment. Atrophy does not seem to have been noticed in these cases.

Treatment of acute and sub-acute orchitis.—This will of course vary somewhat with the cause of the inflammation. In acute traumatic orchitis, which may be taken as the type of these cases, the patient should be kept on his back in bed for at least forty-eight hours, the scrotum supported on a small pillow or on a folded sand-bag, and ice, which will need frequent renewal, applied in a small india-rubber bag or bladder suspended from some form of cradle. If the pillow is not at hand, the scrotum may be well kept up by means of a large handkerchief folded into a triangle; the middle of the base of this is placed below the scrotum, while the ends are brought up and fastened to a piece of bandage attached above the iliac crests. To prevent the handkerchief slipping forwards two tapes should be stitched to the middle of the handkerchief, passed backwards over the perinæum, and tied to the bandage behind. If the pressure of the ice cannot be endured, or if, in a weakly or elderly patient, the severity of the cold of ice is to be deprecated, a layer of lint applied frequently out of iced lead lotion will be found a good substitute. But, as a rule, the application of ice as above directed is the best local application for the first twenty-four or forty-eight hours of acute orchitis; it removes pain, and lowers the temperature more quickly than any other treatment, and by the contraction of the dartos and cremaster which it brings about, it gives well-sustained support and natural rest to the inflamed testis. Numerous other forms of local treatment have been recommended; a few only will be referred to. Occasionally warm applications, from their tendency to cause relaxation of the unyielding fibrous structures which surround the testis, are found more grateful to the patient. In such cases lead and opium lotion or decoction of poppy-heads, applied by means of lint or spongio-piline, are good remedies, but to be of service they require more frequent changing, and are thus inferior to the ice-bag. The question of local blood-letting has been a good deal discussed, but the need of this seldom arises. Where, from the inflammation running high in a plethoric subject, the surgeon makes use of blood-letting, opening one or two of the scrotal veins is to be preferred to the use of leeches. Before the venæsection the patient should stand up, and the parts should be fomented with hot water. But even these precautions often fail in producing sufficient distension of the veins, the condition of the superficial veins giving no adequate indication of that within the tunica albuginea. Leeches, whether applied to the scrotum, or above, along the cord, cause a noisome mess,¹ and give rise to troublesome subsequent itching. Another mode of treatment, which has somewhat recently been much discussed, is that of puncture of the testis. This, which was originally introduced into practice by Vidal de Cassis,² has never been generally adopted by English surgeons. Both the above-mentioned surgeon and Mr. Henry Smith³ of King's College claim for this method that it gives more speedy relief than any other mode of treatment, while it is equally safe and harmless. It is clear that when M. Vidal de Cassis speaks of having operated in this way on more than 400, and Mr. H. Smith on more than 1,000, cases, these surgeons are referring, not to real acute orchitis, which is comparatively rare, but, in a very large proportion of their cases, to venereal epididymitis. It cannot be doubted after the observations of the above-mentioned surgeons and the personal experience of Mr. Macnamara,⁴ that

Duffey, *Lancet*, vol. i. 1881, pp. 161 and 577; Dr. Duffey, 'On Rheumatic Orchitis as a Sequel to Fever,' *Dub. Journ. Med. Sci.* N.S. vol. liii, p. 97. Reference should also be made to a paper lately published by M. Sevestre (*L'Un. méd.*), and *Lan.* Dec. 9, 1882. In these cases the orchitis occurred suddenly during convalescence, with recurrent pyrexia, which may simulate a relapse of the typhoid fever.

¹ This is especially the case if they are applied at night and the patient subsequently gets warm in bed.

² *Journ. de Méd. et de Chir. prat.* Paris, Oct. 1844; and Velpeau, *Anat. chir.* t. iii.

³ *Lancet*, 1876, vol. i. p. 43 *et passim*.

⁴ In the *Lancet*, 1877, vol. i. p. 50, Mr. Macnamara speaks of the 'relief, not only instantaneous but permanent,' which he received from puncture in an orchitis due to a blow against the pommel of a saddle.

puncture will give relief in acute orchitis and epididymitis, though the *modus operandi* of this relief is somewhat obscure. Probably it owns different causes, in some cases being due to withdrawal of a little fluid from an acutely inflamed tunica vaginalis, in others being brought about by the escape of a little blood and other inflammatory products from an organ so tightly girt as an inflamed testis. But even if it be granted that a puncture gives a relief which is a little more speedy than that given by ice and rest, this relief will not be so abiding, and it is not without the risk of producing a hernia of the inflamed and swollen testis.¹ Then, again, of the 1,000 cases in which Mr. H. Smith has made use of puncture, though it is only in the most acute form of the disease that he recommends this treatment, the great majority must have been hospital patients and cases of venereal epididymitis. While I admit the greater need of speedy relief in such patients, I am of opinion that other treatment restores these patients to the power of work almost as quickly and withal more safely. By the better class of patients, on the other hand, whether the affection be orchitis or epididymitis, the suggestion of puncturing an organ so intensely sensitive as an inflamed testis would, as a rule, be at once rejected.² Puncture of the testis may, very occasionally, be not only justifiable but absolutely required in those cases where, after acute orchitis, the presence of pus in the substance of the testis is suspected. Under such circumstances, an anæsthetic being usually advisable, the blade of a tenotomy knife, or of that which bears Sir J. Paget's name, may be lightly passed into the substance of the testis, usually at its anterior border or inner surface, for about three-quarters of an inch, one or more punctures being made if needful, but not too close to each other.

The use of collodion in acute orchitis has been strongly recommended. M. Bonnafont³ who was amongst the first to employ this remedy, states that after the application of collodion the swelling, redness, and excessive pain yield in about half an hour, the cure being complete in two or three days. The collodion seems to act beneficially in different ways—by the withdrawal of heat owing to the rapid volatilisation of the ether, by compression, and by the exclusion of air. For acute cases the above remedy has seemed to me to be very inferior to ice in its power to give relief from pain, while in less acute cases its compression, though undoubted, is weak and tardy.

Next to rest and the local use of ice, general treatment in acute orchitis is of chief importance. For young and strong patients 5 or 10 grs. of calomel should be given at once, and its action kept up by smaller doses, guarded, if need be, with a little pulv. Dover. Salines with antimony in combination with hyoscyamus should be prescribed in some such form as this:—Vin. ant. tart. ʒj., tr. hyosc. ℥ 40, mag. sulph. gr. 10, aq. camph. ʒj. every three or four hours, at first, the dose of the antimonial wine being diminished as soon the pain is relieved, and the frequency of the pulse is reduced; sleep should be obtained either by addition of liq. opii. sed. ℥ 10 to the above, or by injection of morphia. After two or three days of this treatment the patient will usually be able to get up and go about with the testes supported. The application of a strong solution of silver nitrate (gr. 10–20–ʒj.) may now replace the ice, and in two or three more days the testis will bear carefully strapping. In some cases, especially if the ice have been diligently applied, strapping may be made use of after the first forty-eight hours.

If, as occasionally happens, there is any tendency, after the acute inflammation has passed away, for the orchitis to recur periodically, quinine or bark will be found useful.

In the form of orchitis dependent upon gout, the latter is usually of the incomplete form, and acute paroxysms are usually absent. To relieve the pain ice may be employed, or if, from the age of the patient, this is thought unsafe, a lotion of lotio plumbi and rectified spirit in equal parts, applied on lint, and a little frequently dropped

¹ Such cases in which the testis was destroyed by cutting into it are mentioned by Mr. Holmes in his reply to Mr. Smith's paper in the *Lancet*, 1876, vol. i. Mr. Holmes, who fully discusses the question here, and in his *Treatise on Surgery*, 3rd ed. pp. 849, 850, condemns this practice as meddlesome, unnecessary, and dangerous.

² As in a case recorded by Mr. Richardson, *Lancet*, 1876, vol. i. p. 267.

³ *Arch. gén. de Méd.* 1854, tom. i. p. 733.

on without disturbing the part, will give relief. Colchicum will be of little service in these cases. If the tongue is foul, the *primæ viæ* loaded, and the liver congested, a little blue pill or some colocynth and hyoscyamus may be given at night, followed in the morning by a seidlitz powder and a dose of mineral water. Every four or six hours something like the following mixture should be given, Magn. sulph. ʒj., pot. bicarb. gr. 15, infus. buchu ʒj.

Where orchitis follows mumps no lowering treatment is to be adopted. Ice is rarely required in these cases, but the above-mentioned lotion or the application of equal parts of extract of belladonna and glycerine will usually be sufficient. Internally the liq. ammon acet. may be given with bark and small doses of hyd. c. cret. and pulv. Dover, taken every four or six hours. The patient should keep the testis supported for some time after the attack of orchitis, and, owing to the comparative frequency with which atrophy is met with in these cases, should be warned to be careful and remain for a time under observation.

In the rheumatic orchitis the local application of lint or soft flannel wrung out of hot water, with a few drops of laudanum sprinkled on them, will give most relief. In a few days the testis may be strapped with emp. ammoniaci c. hydrarg. or with Leslie's strapping. Internally, if the skin is inactive, something like the following :— Pot. bicarb. gr. 10, pot. iod. gr. 5, mist. gnaici ʒj. four times a day may be tried ; but as these cases usually occur in debilitated subjects, quinine, bark, or cod-liver oil will usually be found useful.

CHRONIC ORCHITIS.

This may be, but seldom is, the result of the acute traumatic form. By far the most common cause of chronic orchitis is syphilis.

Syphilitic affections of the testis.—These have of late years become well recognised. The diffuse form of syphilitic orchitis is the typical form of chronic orchitis. The greater frequency of castration in past years than in the present day may be accounted for by the fact that surgeons were in the habit of removing many chronic indolent swellings of the testis when they reached an inconvenient size (called sarcocele or hydro-sarcocele), which a timely and persevering exhibition of mercury would have cured.

The affections of the testis due to syphilis are as follows :—

(A) ACQUIRED.—(i.) *Syphilitic Orchitis. Syphilitic Sarcocele.* (a) Diffuse, Interstitial. (β) More circumscribed, Gummatous. (ii.) *Syphilitic Epididymitis.*
(B) CONGENITAL.

(i.) *Syphilitic orchitis.*—Syphilitic affections of the testicle occasionally occur during the secondary stage. Usually, however, the gland is not attacked till two or three years after infection, and often not till a much later period. As a rule, the earlier the testis is attacked the more likely it is to be the seat of diffuse orchitis occurring in young and healthy adults, while the later the testis is affected the more likely will the patient be broken down with tertiary syphilis and the affection of his testes be gummatous.

(a) *Diffuse, interstitial orchitis.*—This is simply a chronic interstitial inflammation of the intertubular connective tissue. It may affect certain parts of the testicle, or involve the whole gland. The mischief originates in the appearance in the intertubular connective tissue of crowds of nuclei-like bodies or 'indifferent' cells ; this early stage is followed by an overgrowth of young connective tissue, which gradually becomes more and more fibrous. When the whole testis is affected, owing to the lobular segmentation which is normal to the organ, the masses of fibrous tissue take a somewhat conical form, the base of each cone lying against the usually thickened tunica albuginea, while its apex is directed towards the mediastinum testis. This is shown in the specimen from which fig. 105 was taken, though here the change is advancing from the earlier and diffused to the later and more intense gummatous orchitis.

By the pressure and contraction of the overgrowth of connective tissue the seminal

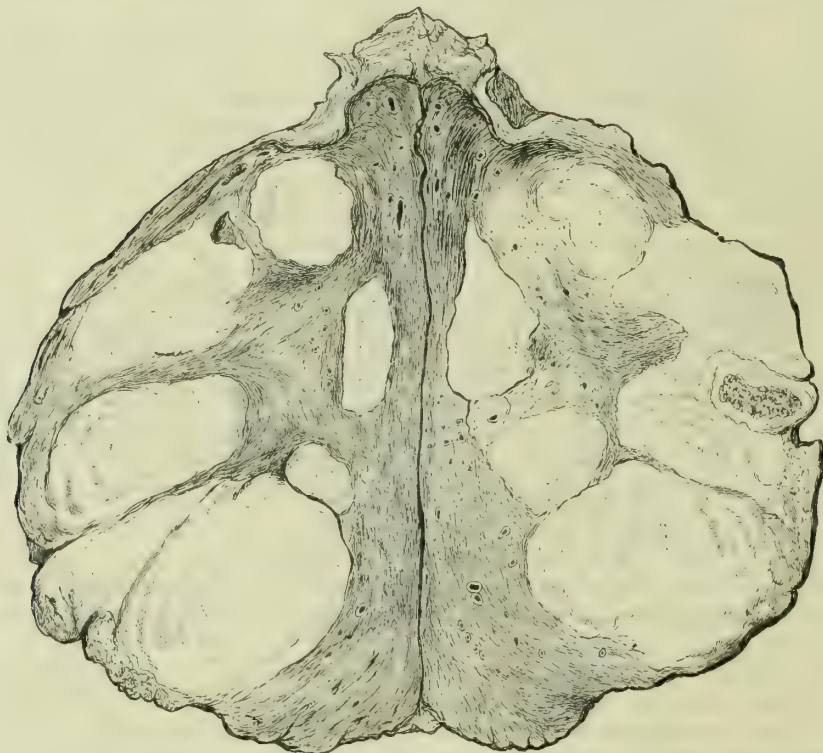
¹ *Arch. gén. de Méd.* 1863, tom. ii. p. 513.

tubes become separated from each other. Their walls are at first thickened, then their epithelium wastes, becomes fatty, and is detached (fig. 106). Occasionally by unequally distributed contraction of this new-formed connective tissue some of the tubes are dilated into irregular, gaping, lacunæ-like spaces. Nothing is ultimately left of the testis save a hard resistant mass of fibrous tissue, with here and there fatty debris, pointing to the relics of seminal tubes.

The epididymis and vas deferens usually remain intact, but in advanced cases they become involved in an extension of the disease from the testicle. For another affection of the epididymis in syphilis see below.

The tunica vaginalis is also affected. At first more or less fluid occupies its sac, but later on this becomes absorbed as the two serous surfaces, thickened and altered,

FIG. 105.—Section of a Testis in which a Diffuse Orchitis is becoming Gummatous.



In the centre vascular fibrous tissue is seen passing, towards the sides, between numerous firm, yellowish, tough, nodular masses. These masses, arranged at the periphery of the testis, appear to correspond to fused and altered lobules, and to be now forming the early stage of gummata. On the right-hand side, which corresponds to the anterior surface of the testis, one of these nodular gummata is breaking down, and at this spot the integuments of the scrotum had ulcerated. Microscopically the gummata consisted of non-vascular, amorphous, granular tissue in which neither cells nor fibres were distinguishable. The very vascular fibrous tissue which passed around, and, in many places, between the gummatus masses, was crowded with indifferent cells, and, here and there, enclosed tubes containing caseating material. The patient had suffered from a node on the sternum. The specimen was shown by Mr. Eve at the Path. Soc. ('Trans.' vol. xxxi. p. 190), and is now in St. Barth. Hosp. Mus. No. 2771.

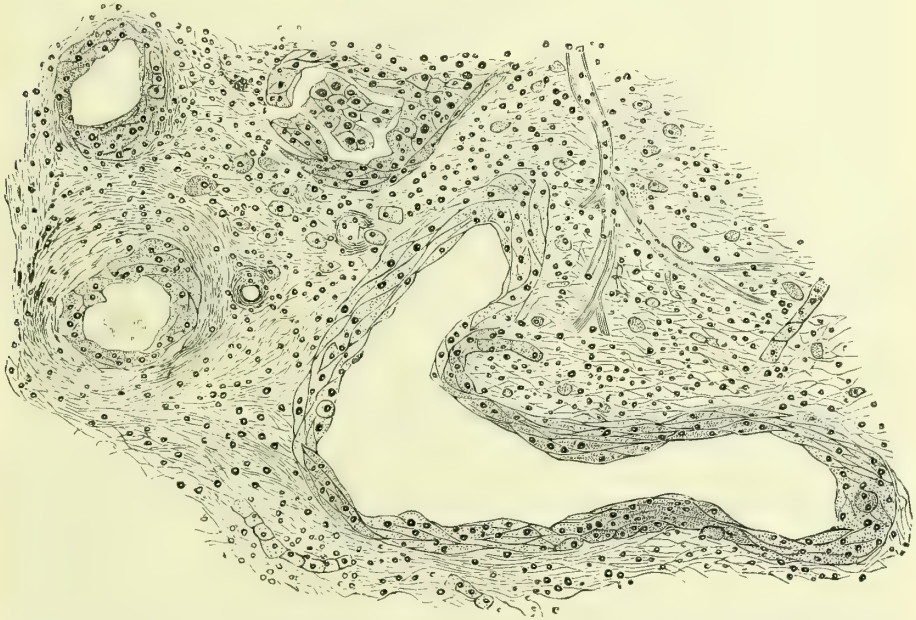
begin to adhere at several spots. In some cases complete obliteration of the sac of the tunica vaginalis is brought about by synechiæ. The tunica albuginea is also much thickened and continuous with the bundles of fibrous tissue which extend inwards into and throughout the gland tissue. Thus a peri-orchitis accompanies the orchitis much as hepatitis and peri-hepatitis often go hand in hand.

(β) *Gummatous or more circumscribed orchitis*.—This may co-exist with the above (fig. 105), or appear at a later stage. It usually implies the previous existence of the diffuse form of orchitis, of which it is to be looked upon as an intenser form. Gummatous orchitis commences in a localised proliferation of the corpuscular elements of the intertubular connective tissue, which is quickly followed by a fatty degeneration. The gummata are usually multiple, and in size varying from that of a pin's head or pea

to a small hazel or walnut. They appear as somewhat elastic and yellowish-white or grey knots. They are firm to the touch, owing to the intermingling of fibrous tissue with the fatty débris of which they consist, and are dry, owing to their slight vascularity. As in other visceral gummata, those of the testicle are surrounded at first by a vascular area, which later on is converted into a whitish fibrous capsule. Within this are the usual broken-down cell-products, intimately mixed with incompletely fibrillated tissue, the central portion being composed almost entirely of fatty granular débris.

Syphilitic fungus of the testis.—This, which is one form of the benign fungus of the testis (p. 533), may occasionally follow on the supervention of acute mischief upon the chronic inflammation of syphilitic orchitis. More commonly it is due to the breaking down of a gumma situated near the periphery of the testis.

FIG. 106.—Section of a Syphilitic Testis in the earlier stage of the disease.



A richly cellular connective tissue forms the chief part of the specimen. At the left side this is becoming distinctly fibrillated. Sections of four seminal tubules are seen, in none of which is the epithelium normal. In two the lumen is occupied by a plug of detached epithelium, which in one tubule is distinctly fatty. The walls of all are thickened, and they are lined by layers of cells, apparently epithelioid, but changing in shape, tending to fuse together and their nuclei to undergo fatty degeneration. In the lowest tubule, which is rendered strangely dilated and shapeless, the cells are drawn out into spindle-forms. To the left of this, small scattered groups of cells suggest tubules which have undergone destruction. At one spot new vessel-formation is very evident. From a section of my own.

(ii.) *Syphilitic epididymitis.*—By most writers on syphilis the epididymis is considered to escape in syphilis, and from this fact a distinction has been drawn between syphilitic orchitis or sarcocele and gonorrhœal epididymitis. M. Dion¹ has, however, drawn attention to the existence of an epididymitis in syphilitic patients, which may exist independently of any lesion of the body of the testis itself. Sixteen cases were met with by this writer, in which an epididymitis occurred in patients manifestly syphilitic. In fourteen there was no lesion of the testis itself, in two syphilitic orchitis co-existed. Of the sixteen patients, ten had never had gonorrhœa, and of the six others it is shown that, save in one case, gonorrhœa could not be at the root of the epididymitis. In addition to the absence of gonorrhœa the chief characters of the epididymitis are its indolence, the often painless condition, the hard bossy outline, and the yielding of the disease to mercurial treatment. It is pointed out by M. Dion that this last point excludes tubercular epididymitis, and also that all other causes of epididymitis were also absent.

¹ *Arch. gén. de Méd.* 1863, t. i. p. 513.

(B) CONGENITAL SYPHILIS.—This is mentioned below under the head of ‘Infantile Orchitis.’

Course and symptoms of syphilitic orchitis.—The syphilitic affections of the testis are markedly insidious both in their commencement and course. There is usually but little pain or inconvenience, save a certain amount of uneasiness along the course of the cord from the dragging weight of the testis. Nocturnal pain is, as a rule, absent. The scrotum is natural both in colour and suppleness, except in the rare cases of syphilitic fungus which have been already alluded to. Hydrocele is usually present, in slight degree at first, but later on is absorbed. In the interstitial orchitis the testis is slowly changed into a pyriform or globular mass, the size of a hen’s egg or an orange. This is usually smooth, heavy, resistant, and devoid of the natural testicular sensation. In the gummatous form the enlargement is less, and the feel may be uneven and knotty when one or more gummata are situated superficially; but this is not always the case, and the same sensation may be given by an unequally thickened tunica vaginalis. Where the gummatous lesion is single and more deeply situated, the diagnosis must depend on the slight enlargement and increased resistance of the testis, coupled with the history of other past or present manifestations of syphilis. One or both testes may be affected, especially in the interstitial orchitis. In the gummatous form, which is later and more distinctly tertiary, the disease is often unilateral. The epididymis is usually to be made out distinct from the testis, but in advanced cases it is concealed and merged in the swelling of the testis. The functions of the testis will always be preserved if appropriate treatment is adopted early; but where both glands are affected, and the patient neglects himself, both impotence and sterility will supervene. If treated early the prognosis is very good. If neglected, relapses are very common. The gummatous stage may also supervene, and, as pointed out by Dr. Wilks,¹ the testis may pass into a condition of cirrhosis, becoming small and hard, the secreting structure being replaced by tough fibrous tissue. This condition, if advanced, will not respond to treatment. Of other sequelæ, suppuration, as already stated, is very rare, and is only likely to be met with in patients broken down with tertiary syphilis, or in those with a ‘tubercular’ tendency.

Treatment.—In the interstitial orchitis mercury should always be carefully and perseveringly given. Amongst the forms which are best and longest borne are, hyd. iod. vir. gr. $\frac{1}{2}$, ext. hyosc. gr. ii., to be taken twice a day in pill. The old-fashioned calomel and opium (cal. gr. $\frac{1}{2}$ or i., pulv. opii. gr. $\frac{1}{3}$) is most reliable when taken once or twice a day in pill. The above will be found more convenient forms in private practice than draughts, or inunction, or the vapour bath, and are also better regulated and of gentler action. Where the tertiary stage is well marked, and where a gummatous orchitis is present, potassium iodide may be preferred. This may be given in some such form as pot. iodid. gr. 5–10, spir. ammon. arom. ʒss., ext. sars. liq. ʒi., aq. ad ʒi. t. d. The quantity of iodide should be increased about every four days, up to 20 or 30 grains, and these doses are best taken freely diluted, as in half a pint of water. But even in these cases of tertiary syphilis small and guarded doses of mercury, e.g. hyd. c. cret. gr. ii., pulv. Doveri gr. ii., to be taken in powder once or twice a day, are often most beneficial. Bark, steel, cod-liver oil, wine, or good malt liquors are always to be recommended when cachexia is well marked, and are emphatically required if mercury is being taken by such patients. In the interstitial form much benefit will be gained by carefully strapping the testis. This may be done over lint spread with ung. hydr. co., or with empl. ammon. c. hydr. spread on leather; but Leslie’s pliable holland strapping, if carefully and thoroughly applied, is quite as efficient and far more cleanly.

Syphilitic fungus of the testis should be dressed with lotio nigra, silver nitrate applied occasionally, and the protrusion gently repressed and the testes supported with strapping.

Infantile orchitis.—Inflammation of the testicle may be met with in infants and in young children. A sub-acute form occurs in infants of a very few months, the testis

¹ *Path. Soc. Trans.* vol. x. p. 210.

being found when the child is washed to be somewhat enlarged and hard. I believe this to be a purely accidental and local condition, that is, one not implying any constitutional disturbance. In several cases which have come under observation, the inflammation seemed to be due to the testis being bruised between the constantly moving thighs of the child; a moist condition, akin to intertrigo of the scrotum and thigh, perhaps contributing to the lesion by preventing the usually smooth and easy movements of the organ. The immunity of the urethra and bladder in children from disease explains the rarity of sub-acute epididymitis in them.

Other forms of inflammation of the testis of a more chronic nature are those due to inherited syphilis. Some undoubted instances of this have been recorded, though the affection is a very rare one, this being probably due to the fact that most manifestations of hereditary syphilis resemble the 'secondary' lesions of the disorder, and also by the undeveloped condition of the organ. M. Gosselin¹ recorded a case of fungating testicle in a child of ten months, in whom characteristic mucous patches were also present around the anus. Dr. Wilks brought before the Pathological Society² the case of a child, æt. five months, suffering from the ordinary symptoms of congenital syphilis, in whom both the testes were much enlarged. After three months and treatment with mercurial inunction, the testes were nearly normal, and the other syphilitic symptoms had disappeared. Mr. Hutchinson showed at a meeting of the same Society³ a specimen of 'gumma of the testis' from a boy, the subject of inherited syphilis. The testis was greatly enlarged, and showed on section an opaque yellow growth, involving almost the entire substance. No softening had occurred.

While tubercular disease of the testis, as stated below, usually occurs in adult life, it has been occasionally observed in childhood and infancy. Mr. Bryant⁴ figures an excellent instance of fungating 'tubercular' testis in a child of two years. The disease had here lasted six months before suppuration took place.

EPIDIDYMITIS.

This is extremely common, especially during early adult life, from the frequency with which urethral inflammation occurs at this period. As will be seen below, it is also by no means uncommon in elderly subjects from irritation of the prostatic urethra. Three forms of epididymitis are met with in practice—viz. the acute, sub-acute, and chronic. Of these the first two may be taken together.

Acute and sub-acute epididymitis.—This may be occasioned by an injury, but much more frequently it is caused by irritation of the deeper part of the urethra, especially the prostatic portion. Thus it is usually due to gonorrhœa, especially in its later stages, when the urethritis has travelled back, and the patient has neglected himself, and indulged in exercise such as riding or dancing, or returned to heavy work; to the irritation of enlarged prostate, which is a little inflamed, especially after the constant employment of catheters; to prostatic calculi; to the prolonged use of the lithotrite, or to the impaction of calculous fragments after its use; to inflammation behind a deep-seated urethral stricture; to the passage of catheters apart from enlarged prostate as above mentioned, this cause being especially likely when the size of the instrument used is rapidly increased; and, but much more rarely, to the operation of lithotomy.

The cause of the frequency of epididymitis during inflammations of the urethra has been much discussed, and several explanations have been given. Thus (1) Sir B. Brodie⁵ and others have considered the epididymitis as due to a metastasis or transference of the inflammation from the urethra to the epididymis. Other authorities on the subject⁶ have used the terms 'sympathy' and 'sympathetic in-

¹ *Union méd.* Nov. 4, 1858.

² *Trans.* vol. xvi. p. 189.

³ *Trans.* vol. xxxi. p. 192.

⁴ *Prac. of Surgery*, 3rd ed. vol. ii. p. 203.

⁵ *Lond. Med. Gaz.* vol. xiii. p. 218.

⁶ Thus Prof. Humphry in the former edition of this work, relying on what appeared to him to be the insufficiency of evidence as to the direct transmission of the inflammation along the vas deferens, wrote as follows: 'I do not know that we can offer any other explanation of its occurrence than is conveyed by the term "sympathetic."'

flammation' as apparently equivalent to the above. Both the terms 'metastatic' and 'sympathetic' have been made use of on account of the rapidity with which the inflammation frequently makes its way from the urethra to the epididymis, and to the apparent absence of any trace of the inflammation of the two parts being a continuous one, from one to the other. (2) On account of this difficulty also, M. Brown-Séquard has explained the epididymitis in these cases by supposing that it is a reflexly congestive condition brought about by the inflammation in the urethra in much the same way as ulceration of the duodenum has been thought to follow on a congestion set up in a reflex manner by extensive superficial burns. (3) Lastly, there is the view supported long ago by Mr. Rose and Sir A. Cooper,¹ that the epididymitis is due to direct extension of the inflammation along the vas deferens. This view appears not only the most probable, but also the one best supported by facts. Thus (α) epididymitis from gonorrhœa usually occurs late in the affection, from the fourth to the sixth week, the inflammation having by this time travelled to the lower part of the urethra. (β) Epididymitis from stricture only occurs when the stricture is situated in the deeper parts of the urethra. (γ) Irritation of the anterior portion of the urethra by fragments of calculus or instruments very seldom causes epididymitis, whereas, if situated far back, these are frequent causes. (δ) It is not unfrequent to find in patients of intelligence that the epididymitis has been preceded by deep-seated pain in the groin, viz. the iliac fossa and inguinal canal, and by a thickened condition of the cord, which all points to direct and continuous travelling of the inflammation from the urethra to the epididymis. (ε) Mr. Hutchinson has recorded² a most interesting case in which, after the operation of lithotripsy, much vesical and prostatic irritation ensued, followed later on by a succession of abscesses in the abdominal wall in each iliac region. Of these it is said, 'These began in each instance by deep-seated pain, great swelling and induration, and in each case we had to cut through a great thickness of tissue to evacuate the matter. I have no doubt that these abscesses had their starting-point in the inflamed vas deferens.'³

Symptoms.—Uneasiness is felt in the epididymis, and intelligent patients will often speak of deep-seated discomfort having existed in the groin for some days before the testis began to swell. Rigors or chilliness and pyrexia are usually also present at this time in acute cases. Uneasiness soon gives place to severe and increasing pain. This soon becomes sickening, and the patient complains that it makes him feel faint. One end of the epididymis, usually the lower, is enlarged and very tender, the swelling increases rapidly and forms an irregular crescentic mass at the back and outer side of the testis, which is separated from the gland itself by a distinct furrow or depression. The tunica vaginalis is in these acute cases usually inflamed, and often contains fluid. Acute hydrocele is much more common in these cases than in acute orchitis, as the areolar tissue of the epididymis is in direct contact with the tunica vaginalis, whereas, in the case of orchitis, the testis and the tunica vaginalis are separated from each other by the barrier-like tunica albuginea. The cord is nearly always painful and swollen. If this swelling of the cord be extreme, owing to the unyielding nature of the fibrous structures of the inguinal canal, the local pain and vomiting, coupled as they usually are with constipation, may simulate hernia. The tissues of the scrotum itself are usually red and œdematous, this being especially marked in cases of gonorrhœal epididymitis.⁴

¹ *Loc. supra cit.* p. 15.

² 'Two Lectures on Orchitis from Irritation in the Prostatic Urethra,' *Med. Times and Gaz.* 1871, vol. i. pp. 419 and 447.

³ Mr. Hutchinson takes care to point out that there was no evidence whatever that these abscesses were pyæmic. They formed solely in connection with the genito-urinary apparatus, and none ever threatened in the joints or other distant parts. The patient ultimately made a good recovery.

⁴ Mr. Hutchinson, in the second of the lectures quoted above, states that 'gonorrhœal orchitis presents certain features which are very characteristic. The cellular tissue of the scrotum is always more or less inflamed, and there is evidence of some effusion into the

The pain and intensity of the inflammation in acute epididymitis usually increase for about four days, then remain stationary for two or three more, and then, decreasing, have usually disappeared by the tenth or fourteenth day. The inflammation rarely proceeds to disorganisation or even to suppuration. Mr. Hutchinson, in the lectures to which reference has already been made, mentions a case of epididymitis due to prostatic irritation, in which the testis itself became affected, and passed into a condition of gangrene, the organ becoming exposed owing to a sloughing abscess in the soft parts. In another case of epididymitis, after lithotrity, the testis became affected and suppurated, an incision evacuating two ounces of stinking pus. Fluctuation could here be detected over the inflamed testis.

In most cases the hardness of the epididymis gradually disappears. It usually remains longest in the globus minor or tail of the epididymis, in which the inflammation was first noticed. In a few cases a little hard lump remains at this spot—a fact of undoubted importance, as it points to the existence of an obstruction, which, if bilateral, may cause sterility. M. Gosselin¹ has published several cases in which, during dissection, the lower end of the epididymis was found to be obliterated in a mass of dense fibro-cellular tissue, apparently resulting from old previous inflammation. No fluid could be injected through the obstruction, and the corresponding vesicula seminalis, though of natural size, was devoid of spermatozoa. While obliteration was most frequently met with at this spot, M. Gosselin has also described obliterations occurring at the head of the epididymis, but as, instead of a single canal, the seminal ducts are here multiple, the obstruction is not so important. One very interesting case of obliteration of the vas deferens throughout the greater part of its course is also mentioned, which may perhaps have been a somewhat similar case to that related by Mr. Hutchinson (p. 526). The noteworthy absence of atrophy in the testis² in these cases of obliteration is to be explained by the abundant facilities for absorption which are provided in the testis. But that absorption is impeded in these cases is shown by the fact that patients who are the subjects of induration in the tail of the epididymis (the most frequent site of obliteration) are liable to uneasy feelings or pain in the testis and along the cord after sexual excitement. Where the inflammation of the epididymis is severe or long continued, it is liable to reach the testis itself.³ The mischief here, however, is not usually of great extent or severity.

Treatment.—Practically no distinction need be made between the local treatment of acute orchitis and epididymitis. In the latter, as in the former, ice, a few days' absolute rest and mild purgatives will very seldom fail to give relief. In sub-acute cases, where the patient is anxious to get about, I have found that the application of a strong solution of silver-nitrate (ʒj. or ʒss—ʒj.), though causing a good deal of immediate smarting, brings about rapid diminution in the size and redness of the affected half of the scrotum, and painful tension of the epididymis, and thus prepares the way for earlier strapping. Where, after an acute attack, the epididymis, though reduced in size, does not yet admit of being strapped, the silver nitrate may also be used with advantage. Care should be taken to prevent the solution travelling into the perinæum or thigh, and to prevent soiling the linen. The testis should be wrapped in lint for the first half-hour. The use of puncture, leeches, and collodion has already been alluded to (pp. 519, 520) in the treatment of orchitis.

In the later treatment of epididymitis, the possibility of permanent obliteration taking place and the condition of the urethra have always to be remembered. If the induration and enlargement of the epididymis linger longer than usual, attention

tunica vaginalis; the swelling is almost always flat-sided, a condition due in part to the great disproportionate swelling of the epididymis, pushing the gland in front of it, and, in part, to moulding of the œdematous scrotum against the thigh.'

¹ *Arch. gén. de Méd.* tom. xiv. p. 405, and tom. xv. p. 40.

² This shows that the absence of atrophy of the testis after an inflammatory attack is not certain evidence that the function of the organ is capable of being performed, which is in accordance with the observations and experiments at p. 528.

³ Velpeau, *Dict. de Méd.*; Demme, *Virch. Arch.* Bd. xxii. S. 177; *Brit. and For. Med.-Chir. Rev.* vol. xvii. p. 76.

should be directed to early reducing the part to its proper size. Careful strapping, the use of the combined iodine and mercury ointments well rubbed in, a mild course of flying blisters, aided by the internal use of liquor hydr. per. and tr. ferr. perch. will usually be found efficacious, if the treatment be persisted in¹ and the patient not allowed to treat this relie of his attack as an unimportant matter; otherwise, if this condition be bilateral and permanent, though there may be all the signs of virility, with desire and power of copulation and emission, there is likely to be no impregnation, in consequence of the absence of spermatozoa in the fluid emitted.²

Sometimes the affection is prolonged, or recurrences of inflammation are induced, by the presence of a stricture or other source of irritation in the urethra; and when this is removed, the testicle usually soon regains its natural state under appropriate management. In the treatment of obstinate or recurrent epididymitis it is, therefore, well to examine the condition of the urethra by passing a bougie. Such cases should not be neglected, because, as just pointed out, the tubes of the part are liable to be impaired or destroyed by the effusion of lymph and other effects of protracted inflammation.

STRUMOUS DISEASE OF THE TESTICLE, OR SCROFULOUS ORCHITIS, TUBERCULAR TESTICLE, TUBERCULAR SARCOCELE, PHTHISIS TESTIS.

Of the above names the first will be here made use of to denote simply a chronic inflammation of the epididymis and testis, probably catarrhal in origin, tending to the production of cheesy masses and pus of low type, and often associated with other obstinate inflammations of the 'strumous' type, *e.g.* of bladder (cystitis), kidney (pyelitis), and lung (phthisis).

Starting-point of strumous disease of the testis.—It has been much disputed whether the exact seat of origin of the disease is in the tubes or in the connective tissue of the organ. The fact that opportunities for examining the disease in its earliest stage are extremely rare will account for the above state of indecision, together with the uncertainty which prevails as to the use of the term 'tubercle,' and the fact that observers have not always stated with sufficient care whether the changes they are describing refer to the testis or epididymis. Amongst those who consider that this disease originates in the interstitial tissue are, to take the writers of later years, Demme,³ Steiner,⁴ Kocher,⁵ who all, though they differ in details, agree in considering that the change is not primarily one affecting the tubular epithelium. Professor Virchow⁶ holds a somewhat similar view as to any epithelial origin, though he puts the starting-point of the disease not in the intertubular connective tissue, but in the connective tissue which forms the wall of the tube of the vas deferens and epididymis. On the other hand, Mr. Curling⁷ and Dr. Andrew Clark in this country, and Gaule⁸ in Germany, consider that the starting-point of the disease is a catarrhal inflammation of the tubes, and that thus the epithelium is the part primarily affected. In the following account of the pathology of strumous testis the changes which take place within and outside the tubes will be described separately. It will be sufficient for the present to remember that the disease begins in the tube of the epididymis; whether it is the epithelium or the connective tissue which takes the initiative must remain at present undecided. The balance of evidence is perhaps rather in favour of this sub-acute or strumous inflammation commencing in the connective tissue of the tube; but even if this be correct, it is evident that changes in

¹ Mr. Curling (*loc. supra cit.* p. 261) quotes a case under M. Godard's care in which sterility of the above-described nature was cured after having lasted eighteen months.

² M. Liégeois (*Med. Times and Gazette*, Sept. 25, 1869, p. 381) has examined twenty-eight cases of bilateral epididymitis at various periods after the attack, and found spermatozoa in only seven; of these the affection in five was from accidental causes—*i.e.* not from gonorrhoea. And he accordingly makes a distinction in this respect between the *external* epididymitis and the *blenorragic* or *internal* (that is, commencing in the interior of the tube), believing that the latter is much more likely to interfere with the passage of the semen.

³ *Virch. Arch.* Bd. xxii. S. 155.

⁴ *Arch. f. klin. Chir.* Bd. xvi. S. 187.

⁵ *Loc. supra cit.* p. 272.

⁶ *Die krankhaften Geschwülste*, Bd. iii. Vor. 21.

⁷ *Loc. supra cit.* p. 313.

⁸ *Virch. Arch.* Bd. lxi. S. 64 u. 213.

the epithelial lining will follow so rapidly as to make it doubtful if the term 'secondary' or 'coexistent' is the correct one to make use of.

Histological changes.—The process starts in the walls themselves of the seminal tubes, usually in those of the epididymis first. Whether this change in the tubes originates in the adventitia or the epithelial lining must as yet remain doubtful, owing to the difficulty of obtaining specimens at so early a stage of the disease. At certain circumscribed spots the connective tissue of the tubes proliferates, and thus becomes infiltrated with round cells, which tend to break down and to become caseous. Nearer the interior of the tube the epithelial cells become swollen and fused together into irregular masses, which become detached into the lumen of the tubes, and lying there recall, ere they too become fatty and caseous, 'giant cells' from their size, irregular outline, and many nuclei which represent the original epithelial cells (fig. 107). Not unfrequently these form still larger masses from the running of the tubes into each other.

As these masses fuse with the caseous products which are produced by the cell-proliferation in the walls of the tubes, the characteristic yellowish-white masses are produced. The vitality of the immediately surrounding tissues being much impaired, inflammation is set up around these masses, and thus the neighbouring intertubular tissue, which is also infiltrated with round cells, becomes invaded and takes a share in the formation of caseous nodules. These, on further examination, often show the following zones, viz. externally richly nucleated, vascular, connective tissue, in which a few scattered and altered seminal tubes may still be met with; more internally there is a zone of cells undergoing fatty degeneration, whilst the centre is occupied by a more or less amorphous mass of molecular detritus.

Usually, by continuous caseation of the outer zone, the nodules increase in size, then fuse to form masses which break down into cavities containing pus, and fistulous openings. More rarely the process is arrested, the masses becoming encapsulated as in the lung by an interstitial inflammation.

The above processes of alteration in the tubes and in the intertubular tissue must obviously have the effect of mutually helping to keep up the mischief in an organ in which tubes and connective tissue lie so closely side by side. Thus it is obvious that inflammation in the walls of a tube will speedily set up irritative changes in the surrounding connective tissue, while this process cannot long continue without affecting other contiguous tubes.

Dr. Payne² has pointed out that there exists 'a close analogy between catarrhal

¹ Dr. Gaule in this paper, and in another in the same Archives two years later, seems to consider that the initiative stage in the morbid process is a catarrh of the tubes of the epididymis, in which the altered and detached epithelium becomes caseous and then eats into the surrounding connective tissue. According to him, all the other changes in the tubes and the intertubular tissue are secondary to this.

² Dr. Jones's and Dr. Sieveking's *Path. Anat.*, edited by Dr. Payne, p. 727.

FIG. 107.—Microscopical Section of 'Strumous' Testis. (From a drawing accompanying a paper by Dr. Tizzoni of Pisa and Dr. Gaule¹ of Darmstadt. 'Virch. Arch.' Bd. lxiii. taf. xi, fig. 5.)

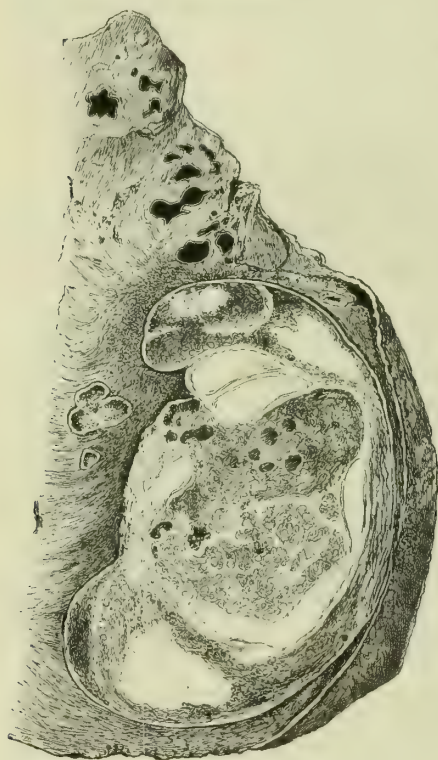


a, epithelium still contained in a lumen of a seminal tube; b, b, b, formation of 'giant cell' bodies inside seminal tubes; c, c, round cells, altered epithelium, and detritus; d, d, intertubular connective tissue loaded with inflammatory cells.

pneumonic phthisis,' in which the main feature is an active proliferation and degeneration of the epithelium, and scrofulous orchitis on the one hand, and between 'chronic interstitial pneumonia,' or 'fibroid phthisis' and syphilitic orchitis on the other.

Changes visible to the unaided eye. (a) *In the epididymis.*—The epididymis is usually affected earlier¹ and to a greater extent than the testicle. The epididymis becomes enlarged at its tail or head, more rarely at its intermediate part (fig. 108). At the period when opportunities are given for examination the epididymis may be enlarged to the thickness of the little finger, and, on section, its convoluted tube is found to be swollen with whitish matter, which is made up of accumulated and altered epithelial cells, granular detritus, and oily material. As the disease advances the tubes of the

FIG. 108.—Section of a 'Strumous' Testis.
(Hunt. Mus.)



Characteristic cheesy masses occupy the head and tail of the epididymis. The testis is also invaded, but to a less extent. An injected varicocele is seen above.

epididymis are still further disintegrated, coils here and there becoming blended and lost, so that the epididymis is thus more and more converted into a mere bag of scrofulous matter. At the same time this matter softens; and, when the softening takes place, the surrounding areolar tissue inflames, and is infiltrated with serum and lymph, preventing the free movement of the skin upon the part. As the softening progresses to suppuration, the epididymis becomes distended and fluctuating, presenting the condition of a scrofulous abscess; the skin becomes more adherent and inflamed, the intervening tissues are removed by absorption, and, the abscess bursting or being opened, the ordinary turbid scrofulous pus is discharged. The opening does not soon close, but continues for a long time—for months or years—to give vent to a thin watery fluid, and now and then to portions of earthy matter; and a narrow channel, with thick walls, feeling like a cord, may be traced from the skin to the diseased part of the epididymis.

As other sinuses form the epididymis is riddled, especially at its head and tail, into small ragged cavities or larger caverns, containing ill-formed puriform matter and broken-down tissue.

Where the process is more chronic, the head and tail of the epididymis are seen to be occupied by pale yellow opaque masses

in which only a few traces of the normal tissues are recognisable.

The disease extends, commonly, for some distance up the vas deferens; and that tube becomes enlarged to two or three times its natural size, and is filled with yellowish-white scrofulous matter, its walls being converted into greyish pellucid matter. By means of this extension the disease reaches other important parts. Thus the prostate becomes enlarged and gradually converted into caseous abscesses, which may discharge by sinuses connected with the deeper part of the urethra, or burrow about at the base and neck of the bladder. The vesiculæ seminales may also be affected, especially the one which corresponds to the affected epididymis (p. 527).

Nor does the disease stop here; an ulcerative cystitis often coexists, and compli-

¹ This is certainly what is seen most frequently in this country. Some observers, however, e.g. Demme (*loc. supra cit.*), consider that the testis may not unfrequently be affected, while the epididymis escapes.

icates the case by the intense pain with which the close of the disease is often hastened. The kidneys also, by an extension upwards, become involved in a suppurative pyelo-nephritis. Finally, a general and fatal tuberculosis may arise from the tuberculous epididymis.

(3) *In the testis.*—In cases where the disease persistently makes head, the side and body of the testicle itself become involved while the above-described changes are going on in the epididymis. In the testicle the disease shows itself as small, yellowish-grey, ‘tubercle’-like bodies. These enlarge and become confluent, and so occupy and consolidate considerable portions, it may be the whole, of the glandular structure, the intervening tissue remaining unaffected. Thus we occasionally find the lobes of the testicle more or less swollen from infiltration of yellowish-white scrofulous matter, yet distinct from each other, and separated by the areolar tissue and the fibrous septa, which still retain their natural characters. In other cases the areolar tissue becomes thickened, coarse and indurated, as in ordinary chronic inflammation; or it may be absorbed, the lobes, as well as the tubes, being thus rendered confluent into one opaque, yellowish-white, cheesy substance, which fills up the whole space enclosed by the tunica albuginea. Soon softening commences, usually at the middle of a lobe; and an abscess is formed, which makes its way through the tunica albuginea and the superficial structures, just in the same manner as does the ordinary chronic abscess. As in that case, a protrusion of the altered substance of the testicle—a ‘hernia testis’—may follow, forming a coarsely granulated mass, covered, perhaps, wholly or in part, by soft white detritus of tissue, and presenting through the ulcerated opening in the skin. The changes that have been described may go on, *pari passu*, in the testis and in the epididymis; so that the glandular substance may be disorganised, and may present at the fore part of the scrotum, while the epididymis is converted into abscesses bursting through the hinder part and sides (fig. 109).

Miliary tubercle of the testis.—This is occasionally met with in the bodies of those dying from acute general tuberculosis. Its comparative rarity is perhaps to be accounted for by the fact that the testicles are often not examined in these cases. Here the change is no doubt situated in the intertubular connective tissue. According to Demme¹ it consists in the formation of small round cells in groups, mostly around the vessels; the vessel in the middle of the tubercle being empty, whilst those in the neighbourhood are dilated and filled, the gland substance is intact. Owing to the speedily fatal termination of these cases of acute tuberculosis, caseation is not seen in this form of disease, which, it is to be remarked, affects chiefly the body of the testicle.

Symptoms and Diagnosis.—The symptoms are usually so characteristic of the affection that the diagnosis is not difficult. Even in the early stage the insidious formation of a small painless nodule in the tail or head of the epididymis, to which the patient’s attention may be only drawn accidentally, is enough to at once excite a suspicion of commencing ‘strumous’ disease. A little later another enlargement is noticed at another part of the epididymis. These little masses gradually run together and form an irregular nodulated mass, which, of somewhat crescentic shape, surrounds the testis at its posterior and outer aspect. As the altered epididymis thus increases in size the testis feels small and usually soft, more rarely one or two

FIG. 109.—‘Strumous’ Testis. (Path. Mus. Univ. Camb.)



a, thickened vas deferens; b, b, suppurated, ragged, partially destroyed epididymis; c, c, c, greatly enlarged and diseased lobes of the testis exposed by reflection of the tunica albuginea. They have been easily separated, the intervening tissue being soft and healthy.

¹ *Loc. supra cit.*

nodular masses are present in its substance. The patient's health suffers but little at first. After a varying period, usually three or more months, one of the nodules in the epididymis becomes enlarged, the soft parts over it are found to be adherent and becoming thinned; before long the skin, dusky-red or purplish and shining at one spot, gives way, and the characteristic discharge of ill-formed pus and caseous material follows. To this succeeds a fistulous sinus, from which weeps constantly thin sero-purulent discharge. Where such a sinus closes a depressed adherent cicatrix remains, the affected part, whether epididymis or testis, being left smaller in size and irregular in shape.

Protrusion of the testis structure, which may occur at this stage, is alluded to below.

In cases of any doubt, the condition of the cord and the vesiculæ seminales (p. 530), the state of the lungs, and the patient's personal and family history, should always be carefully inquired into.

Prognosis.—Clinical observation gives great reason to believe that, under favourable circumstances, serofulous matter may undergo complete absorption, leaving the tissue which had been occupied by it quite unimpaired; and the inference derived from pathological investigation of similar products in other parts of the body is that they may fall into a quiescent state, the more watery elements becoming absorbed, while the remaining constituents are impregnated with oily matter or saline particles, so that the mass is converted into a substance like putty or soft cheese, or, finally, into a dry earthy lump composed chiefly of carbonate of lime. While these changes are going on, the mass is enclosed and isolated from adjacent parts by a capsule of lymph effused around it.

Where the disease is limited to the epididymis and testis of one side, where the patient's lungs and other viscera are sound, where he is able and willing to observe those conditions of hygiene which are suitable to cases indicating like mischief, we should hesitate to condemn a testicle, even though it be the seat of severe disease. It is impossible to know that all the tubules are involved, and it is often astonishing what good results have followed in apparently hopeless cases from judicious treatment when the circumstances were favourable to the improvement of the health and the subsidence of scrofula.

But, on the other hand, when the disease is bilateral, when the lungs are involved, when the cord is much implicated, or when the patient's surroundings do not admit of improvement, the outlook is very gloomy. Steady progression to the vesiculæ seminales and prostate must be looked for, unless the patient succumb, at a more early date, from disease of the lung, or some intercurrent joint affection.

And in those cases where the testis, though withered, remains quiescent, the patient should always be warned of the danger of any fresh inflammation being set up in old 'residual' relics.

Treatment.—The treatment consists, principally, in means calculated to improve the general health and impart vigour to the nutritive processes; and of these, fresh air out-of-doors, and well-ventilated, well-lighted apartments, stand first in importance. Unless the pain and inflammation be such as to necessitate repose, the patient should be encouraged to go out, and to select, if it be in his power, a cool, bracing, rather elevated residence, and, if by the seaside, so much the better. The patient, always warmly clad, should take regular gentle exercise, avoiding alike chills and damp, and confinement and inaction. For poorer persons, some such change of their surroundings is of paramount importance, these cases always doing best when they can gain the advantage of convalescent seaside homes.

The following case is a good instance of the above:—

A man, æt. 33, has been under my observation for two years with the following condition of things. When he first came to me he had typical disease of the right epididymis, commencing with the usual insidious nodular deposit in the globus minor. A much larger deposit existed on the left side, which was already commencing to suppurate, the integuments being red and adherent. There was extensive pneumonic phthisis on the right side; owing to caries of the middle dorsal region, which must have involved three or four vertebræ, a

distinct boss existed here, and the patient suffered from the usual girdle pain. On account of the spinal trouble the patient rested for a few weeks, during which time the disease of the epididymis appeared to extend, that of the left side breaking down still further and discharging. Since this date, for quite a year and nine months, the patient has passed his time at different parts of the seaside and country. The disease in the right globus minor remains absolutely quiescent; on the left side there remained a discharging sinus for some time, which is now quite closed. The mischief in the lung does not appear to have advanced; his back, though deformed, is free from pain, and he is able to follow a light employment. It is to be noted that in this patient there has been no enlargement of the vas deferens or signs of extension upwards.

While the change of air and surroundings is the chief thing wanted, it is often the very thing which cannot be obtained, and we have to struggle on feebly with other means. Next in importance is a rather liberal supply of nutritious food—meat, sound malt liquors, or a glass or two of wine—sufficient to satisfy the appetite, not to quench it. At the present day the last caution is much needed; for numbers of invalids are so plied with food that a natural appetite, and the vigorous digestion attendant upon it, are not suffered to exist. Sponging of the part, and of the body generally, with tepid water is a useful adjunct. Steel, quinine, acids, cod-liver oil, are often of service. Syrup of the iodide of iron, if given for a considerable time, and in combination with bark, has seemed to me useful.

The local treatment, though secondary to the general, is not unimportant; and where there is not the opportunity to carry out the measures on which we most rely, we must be the more persevering with those which are less effective. The part should always be suspended. If it be painful, soothing applications or a leech or two should be applied. If it be not painful, it should be well sponged or sluiced with cold water several times a day. This is the best appliance and, fortunately, it is an easy one; but there is often an inattention to it on the part both of the surgeon and the patient. An external stimulant sometimes does good; and iodine, in a fluid form, is more manageable and answers the purpose better than any other application. It should be used so as to produce desquamation. If abscesses form and are long in coming through the soft parts, a small incision should be made so as not to increase unnecessarily the already impaired vitality of the skin. In some very bad cases where the organ seemed nearly destroyed Professor Humphry has seen very good results from freely laying open the sinuses and cavities, turning out the scrofulous matter and softened structure,¹ cleaning the part by washing and wiping, then freely applying nitrate of silver and plugging the wound with lint, so as to induce active suppuration. At any rate, it is worth while to try this before determining to remove the organ.

The treatment of hernia testis is given below.

HERNIA TESTIS.

This may occur under three conditions—(a) in the course of chronic orchitis nearly always of the syphilitic variety; (β) in ‘strumous’ testis; (γ) in malignant disease, usually encephaloid carcinoma or medullary sarcoma, constituting ‘fungus hæmatodes.’ This last variety of hernia testis contains but little, perhaps none, of the testis structure; it is alluded to below (p. 544).

(a) *Hernia of syphilitic testis*.—This usually takes place in the later tertiary gummatous form of orchitis. This begins either in a gummatous inflammation of the tunica albuginea, somewhat similar to the gummatous infiltration of the perios-teum in the later and more perishable nodes of tertiary syphilis, or more frequently in the softening of a gumma which happens to be situated near the surface (fig. 105). As this breaks down the tunica albuginea is more and more implicated, becomes softened and thinned. The overlying skin and cellular tissue, at first inflamed and adherent, gradually ulcerate, thus allowing of a protrusion which consists of the whitish-yellowish mass characteristic of a gumma, with here and there traces of tubular tissue in the shape of little masses which admit of being unravelled. As

¹ Volkmann's sharp spoons will be found useful here.

the syphilitic fungus increases in size it soon becomes covered with greyish granulation and pus mixed with slough. It usually feels rather firm, is painless, and not inclined to bleed readily. That some of the seminal tubules in the fungus are still permeable is shown by the fact that spermatozoa may often be detected in the discharge upon the dressings of these cases. Owing to the tendency of the skin and dartos to contract with a ring-like cicatrix around the fungus, this often becomes pedunculated and even mushroom-like.¹ It is seldom large, and the testicle has usually become much reduced in size when the protrusion takes place; so that altogether the protruding mass and the remnant of testicle often do not more than equal the natural size of the organ. The amount of the protrusion varies from a small nodule to the whole substance of the testicle. In some cases the entire glandular part of the testicle, and with it the mediastinum, is projected through the tunica albuginea, and stands out beyond the level of the skin; and even then, as just said, the protruding mass is not very large.

The hernia of syphilitic testis and of non-syphilitic orchitis may be also brought about by suppuration of the inflammatory products, either in a gumma deeply situated or at some part of the inflammatory infiltration of the intertubular connective-tissue. These modes of origin of a hernia testis are, however, rare.

Another very occasional mode of origin of syphilitic hernia testis is seen in those cases where the ulcerative process starts inwards from the skin, having commenced in some syphilitic eruption, &c.

Syphilitic hernia testis usually occurs in broken-down cachectic subjects of tertiary syphilis, in patients of strumous diathesis, or in those who have been exposed to want and to lack of treatment. Thus nodes, ecthymatous eruptions, ulcerations of the nose and roof of the mouth, are not unfrequently found to be present at the same time.

(β) *Hernia of 'strumous' or 'tubercular' testis.*—This may sometimes occur after the bursting of an abscess and the discharge of caseous material. It is usually noticed on the outer part of the testis in connection with the infiltrated portion of the epididymis. Occasionally it occurs in connection with the testis itself, usually at its anterior portion. The fungus is paler, more flabby, and more inclined to bleed than in that of syphilis. Other sinuses usually co-exist. The secreting structure of the testis itself is more rarely found in these cases than in the one which has been just described, as owing to the greater disorganisation brought about by the formation and ulceration of caseous deposits, the seminal tubes at the spot corresponding to the fungus have been largely destroyed.

In addition to the above varieties of 'hernia testis,' which start from within the testis, M. Jarjavay² has described a superficial variety of 'fungus of the testicle,' which, unlike the above, does not entail any lesion of the tunica albuginea. This superficial form consists merely of somewhat luxuriant granulation tissue, and springs from the tunica vaginalis. It has been met with after certain operations for hydrocele, as by seton and excision of a portion of the walls of the sac.

Treatment of hernia testis.—In addition to the constitutional and general treatment which has been recommended under the heads of syphilitic orchitis and 'strumous' epididymitis, the following directions as to local treatment will be found useful. Where a hernia testis is foul and sloughy, dusting on powdered iodoform will remove fetor and bring about a healthy condition more quickly than carbolic acid. In the case of the syphilitic fungus, the application of lint soaked with lotio nigra, and as soon as possible strapping the testis with Scott's ointment, are indicated. Carefully adjusted pressure is always useful. Thus, in any case where it can be borne, the red oxide of mercury or iodoform may be dusted over the hernia and strapping applied over lint. When this is not possible the testis should be supported by a suspender, and lint applied soaked in a dilute solution of sulpho-

¹ A similar shape is taken by other protrusions which are also tightly girt by unyielding parts, viz. hernia cerebri, and the granulations which project, after amputation, from the medullary canal in cases of osteomyelitis.

² *Archiv. gén. de Méd.* 4^e sér. tom. xx. p. 129.

carbolate of zinc or sulphate of copper, nitrate of silver being applied by means of a strong solution (gr. xx.-xxx.— $\frac{3}{4}$ j.) every third day or so. Whatever application is made use of, it is essential to clean the surface thoroughly daily, and to dry it carefully on every occasion that the dressing is changed.

Shaving off of any portion of a hernia testis is not to be thought of: there is not only the risk of removing healthy testis structure, but this treatment is always followed by fresh protrusion.

If the treatment indicated above fail, or prove too tedious, the following operative measures may be tried where the general condition of the patient is satisfactory.

By means of an elliptical incision, the ring of tissues which tightly girts the hernia is removed, while at the same time the soft parts are carefully dissected up. Pressure being then made upon the hernia, the soft parts are adjusted over it with as little tension as possible, and held in position with a few points of silver suture. But it will be found that in many cases, owing to the altered vitality of the soft parts, the stitches quickly cut their way through, the flaps recede, the hernia again protrudes, and but a slight amount of primary union is secured. This operation is chiefly suited to small protrusions in fairly healthy persons, where the cicatricial circle of soft parts is very tight.

Another operation which is suitable to these cases is careful nicking of the above cicatricial band and the tunica albuginea at several points of its circumference. Dr. Pagan, of Glasgow, who introduced this mode of treatment, recommended that in order to secure division of the tunica albuginea, the soft parts should first be carefully dissected through.

NEW GROWTHS OF THE TESTICLE.

Under this head come the so-called 'cystic disease,' sarcomata, with the sub-varieties of cystic sarcoma and chondro-sarcoma, enchondromata, though it is doubtful if these exist long without being complicated with sarcoma, the very rare fibromata, and carcinomata, especially encephaloid disease.

CYSTIC DISEASE.

This term has been applied to several different diseases of the testis, most often to imply what we now understand by the term 'cysto-sarcoma.' Under the term 'cystic disease' might be included cystic degeneration, or breaking down of carcinoma or sarcoma of the testis, cysts originating in dilatation of seminal tubes or otherwise in the course of enchondroma, sarcoma, &c., and finally the much rarer dermoid and true hydatid cysts of the testicle. With the more exact pathology of the present day, the general term 'cystic disease of the testicle' should, as far as possible, be laid aside, and it should be specified which of the several diseases of the testicle in which cysts occur is intended.

The only disease to which, for the sake of shortness, the term 'cystic disease' can be applied, is the early stage of cystic sarcoma of the testis. Just as in the female breast, cysts may originate probably from dilatation of the lacteal ducts, contain at first clear serous or muco-serous fluid, remain for a long time innocent, and then after five, ten, or twenty years light up into sarcomata, so in the testicle a very similar sequence may be noted. Thus the term 'cystic disease of the testis' will mean, not a disease distinct by itself, but the early stage of sarcomatous disease of the testis, a stage of varying duration, but one that will be followed sooner or later by rapid increase locally, and most probably by secondary deposits elsewhere.

SARCOMATA.

These are a more common form of malignant disease of the testicle than the carcinomata. The following varieties, in order of frequency, are met with here, viz. round-cell, spindle-cell, and mixed-cell sarcomata. Another sarcoma, which is really

a sub-variety of the round-cell variety, has been met with, viz. lympho-sarcoma, or lymph-adenoma, so called from the likeness of its cells to those contained in lymphatic tissue.

The starting-point of the sarcomata of the testis is probably the intertubular connective tissue.

It is noteworthy that pure forms of sarcoma are not often met with in the testicle, the sarcoma being mixed with myxomatous and cartilaginous tissue, thus forming myxo-sarcoma or chondro-sarcoma. The round-cell sarcoma is the one most frequently met with in the unmixed form, spindle-cell sarcoma on the other hand being usually accompanied by the formation of other tissues belonging to the connective-tissue group, viz. cartilage, mucous, adipose, and even muscular tissue. This fact is partly explained by the lower degree of development, the far more rapid growth, the tendency to secondary deposits, and thus the shorter duration of the round-cell sarcoma.

Another noteworthy point in the clinical history of sarcomata of the testis is this, that though an enchondroma or myxoma may occur as a primary and simple tumour, yet after a time the period of which is most uncertain, they often become sarcomatous by a conversion of their connective-tissue elements into the cells, whether spindle-shaped or round, of a sarcoma, as in the cases alluded to below (pp. 539, 540).

Sarcoma of the testis usually commences in the body of the testis, appearing first as an oval or egg-shaped lump, uniform in outline. It is this absence of any irregularity or bossiness which at first often makes it difficult to distinguish these cases from those of chronic orchitis, especially as a history of a blow and subsequent inflammation may be present in either case. Later on, of course, irregularity of outline and unequal resistance at different spots may both be met with on section. The tunica albuginea is usually not only distended but also thickened; the cavity of the tunica vaginalis contains fluid at an early period, but later on this is usually obliterated. On section the surface of the growth is pinkish and more or less translucent, or greyish-white and semi-opaque in tint, and fleshy in appearance.¹ This latter feature is most marked in the firmer, more slowly growing sarcomata with spindle cells, and in these the surface is often somewhat lobulated, and intersected by numerous bands of white fibrous tissue. In the round-cell and rapid sarcomata these intersecting bands are very much fainter, and the consistency is much less firm, resembling the softness of a close-textured sponge. The presence of cysts is common and will be alluded to below.

Microscopically examined the sarcoma cells, whether round, spindle, or, as is very frequently met with, mixed, are found to occupy the intertubular tissue separating and compressing the seminal tubes, many of which are altered in shape, and show their epithelium replaced by granular fatty matter. Neither in the arrangement and character of their cells, vessels, &c., do the sarcomata of the testis call for any special remark.

Symptoms and course of sarcoma of the testicle.—The disease usually appears either in early childhood,² or in manhood between about the years of twenty-five and forty. It may be attributed to a blow or squeeze, but frequently it is discovered by accident that one side of the scrotum is larger than the other. Where the tumour is composed largely of fibrous tissue and spindle cells, or contains a considerable admixture of cartilage, the rate of growth often takes place slowly for several months,

¹ It is impossible with the unaided eye to always distinguish between a section of some sarcomata and carcinomata of the testis, to wit, between the medullary sarcoma and encephaloid carcinoma. Both show the same cheesy or pultaceous spots, the same white or pinkish-grey tints, and the same extravasations and ragged cavities. The more fleshy the tumour appears to be on section, the more distinct is the evidence of the presence of cartilage, giving, as it were, an appearance of sago-grains on the cut surface, the more abundant, the more defined, and the better developed are the cysts, and finally, the less the tissues of the scrotum itself are involved, the more likely is the specimen to be one of sarcoma.

² Mr. Butlin (*Sarcoma and Carcinoma*, p. 22) considers that sarcoma of the testis is most frequent 'at two periods of life: the first period extending from birth to ten years old, the second from thirty to forty years, and therefore nearly corresponding with the period during which men are most liable to carcinoma.'

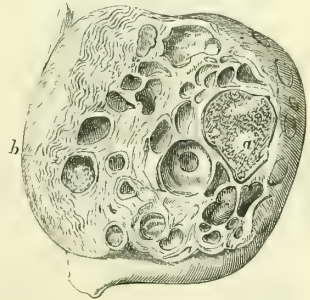
or even for a year or two, but there is always the probability that after a period of varying length, the increase will become, it may be suddenly and unexpectedly, very rapid. Where the growth is composed of round cells, of the nature of medullary sarcoma, the rate of increase is rapid throughout, and a larger size is attained in a few weeks or in two or three months. Pain is not usually a marked symptom; even when the tumour is bulky it is a source of encumbrance rather than of distress. According to the rapidity of growth is the epididymis early or late merged in the general swelling. In sarcomata, especially in the round-cell variety, both testes may be affected, a complication which does not occur in carcinoma. The same secondary deposits may take place, in the medullary form especially, in sarcoma as in carcinoma, viz. in the lumbar glands, in the bones, liver, &c. (p. 543), though with reference to this point it has appeared to me that multiple secondary deposits in the skin follow on rapidly growing sarcomata, not carcinomata. A few varieties of sarcomata will be now described.

Cystic sarcomata.—Cysts may be associated with sarcomata in different ways; the combination of the two is very frequently met with. The following are some of the ways in which the cysts arise; (α) in hæmorrhage, (β) in mucoid softening of myxomatous tissue, (γ) perhaps in dilated lymphatics, as in Sir J. Paget's case alluded to below, (δ) in dilated seminal tubules.

Mr. Curling during the examination of a case of cystic disease proved conclusively that the cysts originated in a dilatation of tubes. Thus at one spot a tube was found to terminate in a dilated pouch, at another the cyst sprang from a terminal bud at the end of a looped tube, or from a similar but lateral bud; finally they may arise in a uniform dilatation of a tube. As the seminal tubules are often found pushed to one side, or expanded over the morbid growth (fig. 110), but otherwise healthy, Mr. Curling¹ considers that the cystic change commences in the rete testis. Professor Billroth² seems to consider that cystic disease of the testis may originate in one of the two following ways. In both it starts within the seminal tubules. In the one the capsules out of which the zoosperms are developed, and which may be looked upon as analogous to Graafian follicles, give origin to cystic formations. In the other a cell-growth takes place within the walls of the seminal canals, newly formed cell-masses grow out of the latter in the form of tubes and sprouts; some of these cell-masses become marked off, and by destruction of the innermost of their contained cells into a thick, and later on into a clear fluid, become converted into cysts. At the same time a new formation of very vascular connective tissue is produced which surrounds the cyst and serves as a support to it. If these views are correct it is obvious how readily, owing to the abundance with which cell-formation will take place in either, cystic disease and sarcoma of the testicle may be combined.

The mode of origin of the cysts having been described, it remains to speak of the structure of the cysts themselves and of the tissue in which they are embedded. The cysts vary in size from that of a pin's head to that of a hazel nut, or even, especially in the complex form, a much larger size. They are met with in two quite distinct forms. The first form consists of simple cysts, with a fibro-cellular wall and lining of tessellated epithelium,³ and fluid contents which may be transparent and serous, or

FIG. 110.—'Cystic Disease' of Testis. (Path. Mus. Univ. Camb.)



a, blood-clot in one of the cysts;
b, glandular tissue of the testis.

¹ *Loc. supra cit.* p. 355.

² *Virchow's Arch.* Bd. viii.

³ This, though usual, is by no means invariable. Mr. Curling (*Med.-Chir. Trans.* vol. xxxvi. p. 452) mentions a case in which cylindrical epithelium was found on growths within the cysts of a case of cystic disease of the testis. Mr. Athol Johnson (*Path. Soc. Trans.* vol. vii. pl. xii.) figures ciliated epithelium which was found on the walls of the cysts in a case of cystic disease of the testis in an infant.

viscid, or mixed with blood. This is the disease to which the term 'cystic disease' has usually been applied, and which is looked upon as innocent. While it may be granted that this form of cystic disease may for a long time remain quiescent, and that when removed in this condition no recurrence *in situ* or dissemination elsewhere takes place, yet it seems certain that there is no distinct line of demarcation between this disease and the one to be next described. It is to be considered an early stage of cystic sarcoma, though the period of taking on a dangerous rate of growth is quite uncertain, and may be long deferred. Thus the intercystic tissue in these

FIG. 111.—Cystic Chondro-sarcoma of Testis. (Hunt. Mus.)



Here and there, but at the lower part especially, cylindrical masses of cartilage are seen in section. Some distinctly compound cysts are present containing foliaceous or lobulated masses of new growth.

cases is here distinctly developed connective tissue, not myxomatous nor richly cellular. There are numerous cases however which show that after an uncertain period of quiescence, a blow or squeeze may start a sarcomatous change in this apparently innocent intercystic tissue.

Quite distinct are the proliferous cysts which are also met with in cystic sarcoma. They usually coexist with a somewhat complex grouping of tissues of the connective-tissue type in the same sarcomatous tumour. Thus in these cases cartilage (fig. 111), myxomatous tissue, muscle striped and unstriped, but usually the latter, may be met with in combination with cysts containing sprouting foliaceous or papillomatous growths within their walls (fig. 111). The origin of these more com-

plicated cysts takes place in the same way as the simpler form, but they are more irregular in shape and soon become occupied with lobulated or foliaceous masses, while the intercystic tissue is frequently myxomatous. The structure of these intracystic masses is also myxo-sarcomatous.

Chondro-sarcoma.—It has been already stated that in cystic sarcoma cartilage is often met with (figs. 111 and 112). A few most interesting cases have been recorded in which, after removal of an apparently innocent cartilaginous growth of the testis, return has taken place speedily in different parts of the body. These are cases in which, though the cartilage seems to form the entire part of the tumour, here and there careful examination shows little soft-grey or pinkish masses, composed of sarcomatous tissue, to the existence of which the recurrence has been due. The minute examination of these little masses shows that this contained sarcomatous

element is nearly always of the spindle-cell variety. The accompanying figure represents a specimen in which cartilage and the more richly cellular and softer variety of sarcoma—medullary sarcoma—occur together.

An excellent instance of chondro-sarcoma has been recorded by the late Mr. Campbell De Morgan.¹

A groom, æt. 35, squeezed his left testis against the pommel of a saddle. When, two months after, the bruising and swelling had subsided, the testis remained hard, and larger than normal. Six months later, when the testis was removed it was found to contain cysts, varying in size, some containing liquid and some solid growth. In the connective tissue between the cysts nodules of cartilage were thickly scattered. The cord was not involved. About a year after the operation the patient's health began to fail, and a year later he died. At the *post-mortem examination* a large mass of new growth was found between the liver and the right groin on the posterior wall of the abdomen, containing cysts and cartilage; small cystic growths of a similar kind were scattered throughout the lungs, while the pleura was studded here and there with small, firm, pink-white nodules. At some points, especially at the edges of the nodules, the cartilage cells could be seen to change their plump forms for those of elongated and oval spindle cells. At other parts the tumour consisted almost wholly of spindle and oval cells arranged in regular tracts.

The origin of the cartilage in new growths of the testicle is alluded to below.

Symptoms of cystic sarcoma² and chondro-sarcoma.—With regard to these varieties of sarcoma, there are but few special points to add to those which have been given already. The cystic sarcoma grows more slowly, often feels more elastic than the simple sarcoma without cysts, and in some cases, where the cysts happen to be superficial, distinctly softened spots can be detected. Tapping of these will give exit to the contents which have been already mentioned, viz. fluid, serous, viscid, or blood-stained. Chondro-sarcomata of the testis will vary in feel, shape, &c. according to the relative amount of sarcomatous, cartilaginous, or cystic tissue which they contain, but it is noteworthy that many of those which have rapidly recurred have presented themselves in the beginning as swellings somewhat oval, with well-defined outline, uneven, slightly bossy surface, heavy when poised, and very hard under pressure, *i.e.* with all the signs of the simple chondromata.

Lymphadenoma of the testicle.—Under this term MM. Monod and Terrillon,⁴ whose opinion on questions connected with diseases of the testis carries weight, have placed some new growths of the testicle, which appeared to them to be distinct both on anatomical and clinical grounds. The chief distinguishing structural feature was the presence of a well-marked reticulum between the cells, very similar to what is met with in lymphatic glands. I have several times seen a similar arrangement in round-cell sarcomata,

FIG. 112.—Medullary Sarcoma³ of Testicle, with a mass consisting of Cartilage Nodules, Fibrous and Cystic Structure in its Substance. (Path. Mus. Univ. Cambr.)



a a a, ragged cavities containing fluid and clotted blood, and many-coloured remnants of clots; *b*, hyaline cartilaginous nodules with central opaque spots.

¹ *Path. Soc. Trans.* vols. xviii. xx. p. 33, pls. xi. xii.

² The results of 16 cases of cystic sarcoma of the testis tabulated in *Med. Times and Gaz.* vol. xi. p. 395, is as follows: the average age, 40; extreme ages, 18 and 58. Average duration, 21 months: extremes, 3 months and 11 years. Supposed cause, blows in 5. All recovered after castration. There were cysts in all, enchondroma in 3, cancer in 1, cholesteatoma in 1. The gland-structure was expanded over the tumour in 8, lost in the tumour in 4, not described in 4. The epididymis was healthy in 6, involved in the disease in 3, not described in 6. Intracystic growths were developed in 3.

³ In the former edition this figure was said to show encephaloid disease and cartilage nodules. I am not aware that any case has been recorded in which, after microscopical examination, cartilage was found to coexist with carcinoma in the testicle. In answer to an inquiry of mine as to this specimen, Prof. Humphry has kindly informed me that it is one which, according to more recent phraseology, would be described as medullary sarcoma.

⁴ *Arch. gén. de Méd.* 1879, tom. ii. pp. 34, 325.

of which the above appear to me, from their general structure, rapid course, bad prognosis, and tendency to complicate both testicles, to be a variety.

Treatment of sarcomata of the testis.—This may be summed up in two words, early castration.

ENCHONDROMA OF THE TESTICLE.

One form in which cartilage appears in the testicle, viz. in combination with sarcomatous and cystic disease, has already been alluded to. Another and at first sight quite distinct form is that in which the cartilage occurs alone in hyaline masses which vary in number, and apparently without cysts or sarcomatous material. But though cases from time to time occur in which the masses of cartilage are united and surrounded by fibrous tissue firm and well developed, without any admixture of softer material, yet clinically it is extremely doubtful whether these apparently simple enchondromata of the testis may not at any time become sarcomatous. No doubt we occasionally meet with cases of small cartilaginous tumours of the testis which have been growing slowly for several years, perhaps three or four, and in which there is no recurrence after removal during the four or five years in which the patient is kept under observation, or perhaps for the rest of his lifetime. But when the close relations of cartilage to the other tissues of the connective type are considered, and when it is remembered how narrow is the border line between these tissues and sarcomata, especially when, under irritation or inflammation, the former tend to recur to their embryonic forms, it may well be doubted whether a cartilaginous tumour of the testicle really deserves the term 'innocent.'¹

To show how certainly a cartilaginous tumour of the testis may run a fatal course though the cartilaginous element may very largely predominate, any other cellular or sarcomatous structure being very little marked, the following well-known case of Sir James Paget's² may be referred to.

A man, æt. 37, two years before admission noticed a slight painless enlargement of the testicle, which perhaps dated to an injury. A year later the testis was severely bruised in a fall. It now gradually enlarged. On admission the swelling in the place of the testicle was roundly oval, unequal on its surface, lowly tuberos, perfectly defined. It measured ten inches and a half in circumference transversely, was very heavy, in most places almost incompressibly hard, but in some soft and yielding. The scrotum was tightly stretched over it, but not adherent or changed in texture. Above this mass the swelling extended up the cord, which felt very large and firm. Three weeks before admission the swelling had become increasingly painful. On removal of the diseased testis and the swelling along the cord, the mass that occupied the place of the testis was of nearly oval form, smoothly invested with the tunica albuginea and the thickened and partially adherent tunica vaginalis. It was composed of tortuous, cylindriciform, and knotted pieces of cartilage, which were closely packed and embedded in tough, filamentous, white connective tissue. Over parts of this mass a layer of seminal tubes was thinly spread out between it and the tunica albuginea. Above this mass, along the cord, were masses, conical, oval, or rounded, the upper ones of which resembled a chain of enlarged lymphatic glands, and contained, as they were followed upwards, an increasing amount of soft structure, which on examination was found to be filamentous and densely nucleated.

The patient recovered remarkably well from the operation, and left the hospital apparently free from disease. In about three weeks, however, he returned, much more feeble, panting

¹ It should be mentioned, however, that a recent English authority, Mr. Butlin (*Sarcoma and Carcinoma*, p. 25), considers that some cartilaginous growths of the testicle consist of pure cartilage, and therefore are entirely innocent. It is however noteworthy that Mr. Butlin, with his extensive knowledge of the literature of the subject and his acquaintance with the preparations in our museums, is only able to refer to one specimen of pure cartilaginous tumour (No. 2,783, St. Barth. Mus.) The tumour here 'was of small size, and composed of hyaline cartilage, which, in its aspect and disposition, resembled that of the malignant tumours, but there was no softer tissue present save a thin layer of fibrous tissue around and between the portions of cartilage.' The growth had existed four years in a young man æt. 22. Four years after castration he was 'alive and in perfect health.' There is, however, nothing to show that in this case an injury might have not set up inflammation in the fibrous tissue, and thus produced cell changes in the fibrous tissue, and thus a return to its embryonic stage, in this way bringing about sarcomatous degeneration, though at the time of examination no soft material was present.

² *Med.-Chir. Trans.* vol. xxxviii. p. 250.

on the least exertion and scarcely able to walk. Ten days later death took place suddenly, the chief symptoms having been referred to the lungs by increasing breathlessness, though the physical signs remained somewhat indefinite.

Post-mortem examination.—Two dilated and tortuous lymphatic vessels ran upwards from the scar, being filled with growths similar to those met with below. These became connected above with a swelling resembling a hen's egg, probably a diseased lymphatic gland, which adhered closely to the front of the inferior cava. At this spot a cartilaginous growth projected from one of the lymphatics into the cavity of the vein. It was branched like a stunted, leafless shrub, and one or two isolated tuftlike growths of cartilage were attached to the inner coat of the vein close by. The only other evidently diseased parts were the lungs, which were so much enlarged by the formation in them of cartilage masses, as to weigh together eleven pounds and a half. The cartilage either existed in the healthy pulmonary tissue as cylindrical, nearly spherical lobed masses which could be easily shelled out, or were attached as small shrublike growths to the lining membrane of the larger branches of the pulmonary artery.

Origin of enchondromata in the testicle.—The mode of production of a tissue like cartilage in soft parts such as the testis was never satisfactorily explained till Professor Virchow¹ showed that it originated in the interstitial connective tissue of the organ. This writer points out that the connective tissue is often in a state of irritation of traumatic origin, especially after a contusion, and that thus irritated it later on undergoes conversion into cartilage, this conversion being compared to what takes place in the periosteum after fractures, at the time of the formation of cartilaginous callus.

It is readily intelligible how this cartilage, at first highly cellular, and originating in inflamed and irritated connective tissue, may a little later find its way into the lymphatics which so richly abound in the testicle, a view which seems more probable than that according to which the lymphatics were the starting-point of the cartilaginous growths.²

Symptoms of enchondromata of the testis.—These will have been gathered from what has been written above. Among the most important are hardness, a bossy or lobulated outline, and usually a slow rate of growth, perhaps dating back to an injury.

Treatment.—Early castration should always be performed. Not only is it impossible to tell how far the nature of the connective and fibrous tissue between the masses of cartilage is simple or cellular, innocent or sarcomatous, but it must be remembered that an enlarged testis is especially liable to injury, just as a hydrocele may easily be converted into a hæmatocele. Now it has been proved that after injury sarcomatous action may readily be lighted up in tissues which may have up to that time been simply fibrous or lowly cellular. And I may here remind the reader of a fact to which Professor Rindfleisch³ has drawn attention, and which is of the greatest clinical importance. 'The glandular and other organs of generation are generally far more prone than other parts to exhibit a transition of simple inflammatory irritations, of ulcers, operation wounds, catarrhal over-growths (hyperplasiæ), into sarcomatous, and ultimately into cancerous degenerations. The longer a formative process persists at any point in the generative system—as *e.g.* the external os—the more marked does the tendency towards luxuriant proliferations, and finally to carcinosis, become.'

FIBROMATA OF THE TESTICLE.

These are extremely rare. One of the best authenticated and most reliable, on account of the microscopical examination, is a case which was brought before the Pathological Society by Mr. Warrington Haward.⁴ The fibrous tumour in this case sprang from the tunica albuginea.

A man, æt. 81, had noticed gradual enlargement of the right testis for eight years. It

¹ *Die krankhaften Geschwülste*, Bd. i. Vorl. xvi. *Virch. Arch.* Bd. viii. S. 402, tab. ix. fig. 12. For other remarks on the inflammatory starting-point of these growths, the initial stage of irritation, and what may be termed the pre-enchondromatous period, W. Busch, *Chirurg. Beobachtungen*, S. 57, may be consulted. See also Virchow, *Char. Annal.* 1858, Bd. iii. s. 6.

² Sir J. Paget, *loc. supra cit.*

³ Rindfleisch, *Path. Histol.* (Syd. Soc. Trans.), vol. ii. p. 197.

⁴ *Path. Soc. Trans.* vol. xxiii. p. 168.

was painless, but inconveniently heavy, and caused a dragging sensation along the cord. The right testis was nodulated, hard, elastic, heavy; some nodules being, however, less hard than others. The cord was not enlarged, the skin was not adherent, nor could any tumour be felt in the abdomen or elsewhere. The growth sprang from the tunica albuginea, the secreting structure remaining unchanged. When cut into it creaked under the knife, the sections exhibiting numerous opaque white bands arranged in various curves, between which was a greyish homogeneous basis. The microscopic appearances were those of ordinary wavy fibrous tissue, for the most part well developed.

M. Cruveilhier¹ figures what appears to be a fibrous tumour originating in the substance of the testicle itself.

He observes that it closely resembles a fibrous tumour of the uterus, or rather the tissue of an unimpregnated uterus. It resisted and creaked under the scalpel. It was composed of contorted and interlaced greyish-white fibres forming lobules, with vessels penetrating their interspaces. It was very heavy in comparison with the size, which was twice the natural size of the testicle. At the upper part of the tumour was a gelatinous mass, which seemed to result from an alteration of the fibrous tissue. M. Cruveilhier had several times observed a similar alteration in the fibrous structure of the uterus. He could discover none of the natural tissue of the testicle, and believed that the fibrous tumour was formed at the expense of the cellular tissue which unites the seminal tubes, and that the proper tissue of the gland was atrophied from compression.

It seems probable that microscopic examination would have shown this to be a fibromyoma of the testis.

Myomata of the testis are extremely rare. The muscular tissue may occur as a solitary mass,² or in combination with other tissues in cystic sarcoma of the testis.³ It is usually of the unstriped variety. Rokitsky⁴ has described a specimen which was as large as a goose's egg, and contained striped muscle. The presence of muscular tissue in the testis has been explained by supposing that it originates in some inclusion of the muscular tissue of the mesoblast.

CARCINOMA OF THE TESTICLE.

The encephaloid or soft variety of carcinoma is not unfrequently met with in the testicle. Of scirrhus a few authenticated instances are on record. 'Melanotic cancer' has also been said to have occurred here, but no minute examination of the structure of these cases is given, and it is probable that they were cases of melanotic sarcoma.

ENCEPHALOID CARCINOMA.

It is well known how different specimens of this form of carcinoma vary in the same organ, both in the amount and in the firmness of their fibrous matrix. In the testicle, however, the fibrous element is usually but little marked, delicacy and a high degree of vascularity being its most striking features. On the other hand, the alveolar structure stands out very prominently, the alveoli being crowded with epithelium which recalls that of the seminal tubules. It is highly probable that, as in the liver and kidney, the starting-point of soft carcinoma of the testicles is to be found in the normal gland-epithelium of the viscus. Thus Birsch-Hirschfeld⁵ in a case of this kind succeeded in tracing the epithelium of the as yet unaltered tubules into that of the alveoli of the growth. The tubules became irregular in shape, their enlargements and protrusions became crowded with proliferating epithelium, and after awhile these epithelial cells were found to be no longer contained in tubules, but to be passing into the surrounding tissues and thus taking part in the growth itself.

Encephaloid carcinoma usually begins at one point in the centre of the testicle, or in the rete; and the tubuli of the lobules are at first often spread out over it. It has its origin less frequently in the epididymis. It is only when the tumour is examined in an early stage that we can tell where it began; for all the structures soon become involved and destroyed by the disease, and the whole is

¹ *Anat. Path.* 5^e livr. pl. i. fig. 3.

² Rindfleisch, *loc. supra cit.* p. 197.

³ Billroth, *Virch. Arch.* Bd. viii.

⁴ *Wien. Zeitschr.* v. 1849.

⁵ *Archiv der Heilkunde*, ix. 3, 537. 1868.

reduced to a cancerous mass, in which none of the natural components of the testicle can be traced. The mass has a soft pulpy consistence and, commonly, a more or less uniform white or pinkish-white colour. When squeezed, a creamy fluid oozes from its cut surface at a multitude of points; and if a stream of water be directed upon it, the greater part is washed away, leaving a flocculent, filamentous, areolar structure, in the interstices of which the creamy fluid had been contained. It is usually so soft, and the areolar basis is so fragile, that it is liable to give way in consequence of a slight blow, or without any such cause the blood becomes effused in its substance. This may take place at many points, interstitially or into ragged cavities formed by the pressure of the blood; and the effused blood, undergoing changes, gives rise to a variety of appearances and discolorations. Sometimes the fibrous skeleton is thicker and tougher, giving a firmer consistence to the mass and simulating 'fibrous tumour,' and it may be arranged in places concentrically, so that the more fluid elements appear as if they were arranged in cysts.

Changes due to fatty and caseous degeneration of parts of the growth are very common. Softening may occur, producing cavities filled with grumous pultaceous substance; or the cells and tissue may become impregnated with oily matter, giving a yellow colour to parts. None of these changes are of much practical importance, or affect materially the progress of the disease.¹

Gradually the mass increases; sometimes, however, not quite steadily. There are often periods during which it seems to be quiescent; or an actual temporary diminution of size may be caused by absorption of fluid effused during the earlier stages into the tunica vaginalis. The hope thus engendered is only destined to be soon dispelled by the rapid progress of the malady. The tunics of the testis yield under the pressure of the quickly increasing tumour more readily than might have been expected, and become stretched to a very great extent, so that although the tumour may attain to large size, they seldom give way. Even when the tunica albuginea has given way the scrotum expands for awhile. It may then become adherent and ulcerate, and the true fungus hæmatodes appears growing rapidly with a sloughy surface which bleeds readily. But as a general rule, before there is time for this to have taken place the testicle has been amputated or the disease has extended along the spermatic cord to the abdomen, the lumbar glands and other organs have become involved, and the patient has sunk under the depressing and destructive effects of the disease.

The surfaces of the tunica vaginalis are usually partially adherent; what remains of its cavity, especially at the upper part, is filled with blood-stained fluid.

Separate deposits may be detected in the areolar tissue along the cord. The lumbar and pelvic glands become affected, and large masses of the growth may be found reaching upwards along the aorta and vena cava as far as the diaphragm. The bones of the lumbar vertebræ are often more or less destroyed,² and the liver and the lungs frequently contain secondary deposits.

Course and symptoms of carcinoma of the testis.—The situation of the affected testis is at first occupied by a regular oval or pyriform mass. This is at first rather firm, and the firmness is uniform and the surface smooth. After a time the mass become softer, at some parts more than others, so as to have a pulpy, elastic, or fluctuating feel, tempting a lancet-thrust. It is not commonly very tender or painful. If there is pain, it is dull, not acute or lancinating. Pressure does not elicit at any part the peculiar sensation of the testicle being touched. The veins of the scrotum become turgid. The cord is free at first, and the vas deferens can be felt to be natural. Soon the cord becomes thick and full from turgescence of its vessels, perhaps thick and firm from deposit of medullary matter in it. As the

¹ In a case which lasted more than five years the slow progress was attributed to the process of retrograde metamorphosis in the centre of the tumour nearly balancing that of growth at the circumference. *Trans. of Path. Soc.* vol. x. p. 205. In another case of similar duration the mass was firmer than usual. *Med. Times and Gaz.* vol. xx. p. 291.

² In a patient of Mr. Cline's, referred to by Sir B. Brodie (*Lond. Med. Gaz.* vol. xiii. p. 408), a year after castration complete paraplegia made its appearance, the cord having become involved in the course of carcinomatous erosion of the vertebræ.

lumbar glands become involved the swelling thus formed may usually be felt in the loin. Pain is now a more marked and constant symptom. It is complained of along the cord, in the loin, and sometimes in the back and down the thigh; occasionally it is present in paroxysms, to use the patient's own words, 'doubling him up.' Another sign that the disease has now reached an advanced stage is seen in the interference with the venous circulation brought about by the masses of new growth. The veins of the scrotum become still larger and more varicose, the lower extremities may become œdematous. Thus it comes about that as the disease progresses the health suffers, the patient becoming weak and thin, with anxious expression. It is, however, important to remark that this alteration in the general health is by no means constant, or even usual, in the early stages, and that it has, therefore, no necessary connection with the malady, but is only a result of the effect of the malady upon the constitution. So much is said and written about cancerous cachexia, that cachexia comes to be regarded as a necessary associate of cancer. Hence physicians and surgeons rely upon it as a means of diagnosis, and conceive that a disease cannot be cancerous because the patient's health is good; whereas, in reality, cancer, especially in early and middle life—the periods in which the testicle is most commonly attacked—fastens itself often, perhaps oftenest, upon those who are well nourished and florid, who seem the most healthy and robust, and so give promise of long life and vigour.

The formation of 'fungus hæmatodes' from a protrusion of the carcinomatous testis through its coverings has already been alluded to. The occurrence of this is rare nowadays owing to castration being usually recommended and accepted by the patient before this stage is reached.

Even where no attempt has been made to remove the growth ulceration does not always take place. The closing stage of the disease is always a very sad one. Pain and tenderness of the abdomen increase, the appetite fails utterly, nausea and vomiting set in, the face becomes wan and pinched, the skin somewhat jaundiced, while the rapid emaciation of the parts above the disease causes a painful contrast with the swollen and œdematous lower extremities; the pulse becomes increasingly thready and rapid, hiccough is often present before the closing of the scene, and thus the patient sinks.

Carcinoma of the testis may make its appearance at any period of life, but it is most common in the first half of adult life, *i.e.* from twenty to forty.¹ It is rare after sixty, and practically unknown in infancy.²

Encephaloid carcinoma of the testicle is usually rapid in all its stages. The average duration of the disease is eighteen months to two years. Where the disease is said to have been of longer duration, it is not improbable that the testis, during the earlier part of the time was not affected by carcinoma, but by some inflammatory disease on which, at a later period, carcinoma supervened. It is well known how often malignant disease attacks organs damaged by previous inflammation, though this refers, to speak more exactly, to sarcomata rather than to carcinomata (p. 541).

Encephaloid carcinoma never attacks both testes, a point of distinction between it and medullary sarcoma.

Diagnosis of malignant disease of the testis.—Under this head both carcinoma and sarcoma will be included. In the early stage these growths are liable to be confused with chronic inflammatory enlargements of the testis owing to their often possessing at this period an oval shape, a smooth outline, and a certain degree of hardness. A little later the indistinct fluctuation which accompanies the softening that is now setting in, coupled perhaps with the presence of fluid in the cavity of the

¹ Mr. Butlin (*Sarcoma and Carcinoma*, p. 21) writes as follows: 'Though after twenty years no age was free from its occurrence, carcinoma of the testis was most frequent between the ages of thirty-five and forty-five.'

² Mr. Butlin (*loc. supra cit.* p. 22) thus speaks of the rarity of carcinoma of the testicle in infancy: 'I imagine before the age of ten two causes concur to render carcinoma rare: first, the little liability to cancerous degeneration of epithelium of any part at so early an age; second, the inactive condition of the epithelium of the testis before the age of puberty.'

tunica vaginalis, causes a deceptive resemblance to an old hydrocele or hæmatocele with thickened walls, especially where, as may happen with the last-named disease, transparency is entirely wanting, and the tumour feels heavy and fluctuates obscurely.

The following are amongst the points upon which most reliance may be placed. Continuous and quickly progressing solid enlargement of the testis without inflammation; greater weight,¹ unequal consistency of the swelling at different parts of the surface, absence of transparency, tendency of the scrotal veins to become enlarged, and of the scrotal tissues to become adherent, and finally increasing aches or painfulness.

In some doubtful cases additional information should at once be sought for by tapping or an exploratory puncture carefully enlarged. The latter is preferable, as it gives more certain information, and is the best treatment in those cases of hydrocele and hæmatocele that are likely to be mistaken for malignant disease. Where possible the incision should be made with antiseptic precautions. The amount of blood which flows through the cannula of a trocar thrust into a testicle the subject of rapidly growing malignant disease is sometimes so great as to lead to the supposition that it must be a hæmatocele. It is to be remarked, however, that in such cases the diminution of the swelling is not so proportionate to the flow of blood as it is in hæmatocele. Furthermore, the blood is usually bright, not dark and altered as when it is drawn off from an old hæmatocele. This subject has also been alluded to (p. 510).

In those cases where the swelling is small, and may perhaps be due to chronic inflammation, a course of mercury, or potassium-iodide, combined with careful strapping may be justifiable; but where the case is of any duration and where the delay involved by the above treatment may perhaps be fatal, an exploratory incision made with antiseptic precautions will be the wiser course.

Treatment.—Early castration is imperatively required. A sufficient number of cases have been recorded to show the benefit that may result from the operation. Thus Mr. Curling² mentions four cases in which after removal of the testis for malignant disease, *i.e.* of the medullary or encephaloid variety, life was prolonged for fifteen, five, nine, and twelve years, and in the last three cases the patient was still alive when the last report was received. And even if, as happens most frequently, the

¹ The late M. Nélaton used to cast great doubt upon the value of specific weight in the diagnosis of tumours of the testis. Remarks of his on this subject will be found in the *Arch. gén. de Méd.* 1857, tom. ii. p. 738; and in the American edition of his *Clin. Lect. on Surg.* from notes by Dr. W. F. Atlee, p. 633 *et seq.*, are the following remarks: 'Great weight of the tumour is found in authors as one of the symptoms of cancerous affection of the testicle, but long ago he, M. Nélaton, had his doubts about it, and the following is the result of his examinations: A large glass full of water was in readiness, and a testicle after its ablation was put into it, the displaced water being received in a basin in which the glass stood. The displaced water, of course equal in volume to the testicle, was then weighed, and after it the testicle itself. This was done on many different occasions, and it showed that if the cancerous mass weighs 250 grammes, the water will weigh 245. Now it is most certainly impossible for any hand to detect so small a difference as this; and moreover it must be recollected that the contents of a hydrocele are serum, which is heavier than water; again there is the testicle, and in addition to the rest are the envelopes of the part, the same in both cases, and tending to equalise still more the specific gravity.' In another case the tumour weighed 144 grammes, and the water which it displaced, 135. In a third case the difference was about five grammes. The following are the concluding remarks of the first-named article: 'On peut donc dire que le signe tiré du poids spécifique des tumeurs du testicule est un signe qui ne saurait avoir aucune valeur. C'est là, dit M. Nélaton, un de ces signes qui ont été inventés dans le cabinet, et qui ne sont transmis jusqu'à nous que parce que personne n'a songé à en vérifier l'exactitude.'

² *Loc. supra cit.* pp. 341, 342. Mr. Curling also refers to cases quoted by Dr. Baring, of Hanover (Ueber den Markschwamm der Hoden), in which considerable intervals had elapsed since the removal of the testicle—viz. five years in two cases, three and two years in two others, and the patients were still in the enjoyment of perfect health. In the *Med. Times and Gaz.* 1859, vol. ii. p. 287, a case of Mr. Cock's is mentioned in which a patient remained in good health for six years after castration for medullary cancer, being at length lost sight of in consequence of his emigration to Australia.

disease returns, a useful life may yet be prolonged,¹ the patient, rid of a wearisome encumbrance, is made more comfortable, and, towards the close, death from internal deposits of malignant disease is not accompanied with the same distress both to the patient and those around him as when the disease is situated externally.

As a rule, no operation should be performed when the cord is extensively involved, when masses can be felt deep-seated in the iliac fossa and lumbar region, when there is any evidence that the liver or lungs are involved, or when the jaundiced sallow tint and rapid emaciation point to the disease having become general. In cases at all advanced, though the patient might be rid of an encumbrance, the operation would be very liable to be followed by a low form of peritonitis, or, before the wound was healed, swelling would probably appear along the inguinal region and a protrusion of the growth take place from the upper extremity of the wound.

SCIRRHUS OF THE TESTICLE.

This form of carcinoma is of extremely rare occurrence in the testicle. Its existence has been much disputed and even denied by many pathologists. Thus Rindfleisch² states that soft cancer is the only form which affects the testis. Mr. Butlin³ has never met with any case which, to his mind, has been proved to be scirrhus by microscopical examination. Lebert, Forster, Virchow do not, as far as I have been able to make out, recognise the existence of this variety in the testicle; on the other hand Klebs⁴ gives a very complete account of a specimen which he found in the Anatomical Museum at Prague. The fullest attempt to establish the existence of this variety of carcinoma of the testicle will be found in a paper by M. Nepven.⁵ This writer considers that, though rare, scirrhus of the testis does occur, and that the following are amongst its best marked features. The age at which it appears is more advanced than in the case of encephaloid carcinoma. Its commencement is very obscure and its course extremely slow, the mean duration of eight cases having been six years. The size attained by the diseased testis is usually by no means great, thus contrasting with the great development attained to by many soft cancers of the testis. The hardness of the tumour is extreme; microscopically, the carcinoma consists of very thick connective-tissue trabeculae, in which the alveoli contain epithelial cells of which the polymorphism is clearly marked.

DERMOID CYSTS OF TESTICLE.

Like the ovary,⁶ the testicle is occasionally the seat of dermoid cysts having much the structure of true skin, with cuticle, hair-bulbs, and sebaceous follicles, and containing the products of these structures, viz. epithelial scales in various states, hairs, and waxy or oily matter. Sometimes, in addition,⁷ masses of bone, with or without teeth, are embedded in the wall of the cyst; and there may be other solid matter, fibrous or cerebriiform, with cavities containing fluid of various colour and consistence. The osseous masses, which may consist of true bone, are of two kinds; thus they may be of irregular shape, and uneven on the surface; and the teeth, which may have crowns and fangs like ordinary teeth, are commonly crooked and disposed in a disorderly manner, quite unlike the teeth in a jaw. In other cases the bone is better formed and contains normal teeth. Thus in a dermoid cyst removed by Dr.

¹ Mr. Curling (*loc. supra cit.* p. 344) relates the case of an eminent barrister who for two years and a half after the removal of a testicle for encephaloid carcinoma was able to continue the practice of his profession to the great advantage of his family, death ultimately taking place from a recurrence of the disease in the lumbar region.

² *Path. Hist.* Syd. Soc. Tr. vol. ii. p. 194.

³ *Loc. supra cit.* foot-note, p. 13.

⁴ *Handb. d. Path. Anat.* S. 1,008.

⁵ *Arch. gén. de Méd.* 1879, tom. i. pp. 129, 314.

⁶ Where from two-thirds to four-fifths of all the known cases occur.

⁷ Thus Kocher (*Pitha und Billroth, Handb. d. allg. und spec. Chir.* Bd. iii. Abth. 2, S. 392) divides these cysts into teratoma simplex and teratoma complicatum; under the latter come those cysts which contain bones.

Van Buren¹ from the testicle of a boy, a portion of well-formed inferior maxillary bone was found with several molars, and a bicuspid tooth firmly fixed in it. These tumours have, in most instances, been observed soon after birth, and are, probably, usually congenital. The rate of their increase varies a good deal. Sometimes they do little more than increase *pari passu* with the growth of the individual; or they may grow at a somewhat quicker rate; and they are liable to sudden accessions of increase, which may be due to an injury, and may be attended with inflammation. The inflammation has, in one or two instances, gone on to suppuration; and the bursting of the abscess has been attended, or followed, by the discharge of oily matter, hair, teeth, or bony fragments, a fistulous opening sometimes remaining as when a similar cyst in the ovary suppurates and discharges. In the greater number of recorded cases these masses appear to have been developed in the testicle; but it is not certain, from the description of other cases, that this was so; and in one described by Velpeau² the tumour could be dissected from the testicle, which was slightly atrophied.

The mode of origin of these cysts is quite obscure. The following are the views on the subject. (a) In accordance with the views of Geoffroy Saint-Hilaire,³ these tumours have been thought by most pathologists to be due to 'fœtal inclusion;' that is to say, it is conceived that the more or less imperfect germs of a second fœtus have been included in the testicle during development. It may, however, well be doubted whether such a process ever takes place; and the probability of its being the cause of the formations in question is by no means accepted in the present day. In favour of this view may be brought forward the very strong resemblance that some of the bones in these cysts bear to normal bones of the skeleton,⁴ and the fact that such cysts, though most common in the ovary and the testicle, which may be supposed to possess an unusual degree of formative power and activity, are not unknown elsewhere.⁵

(b) That these cysts are the result of departures from the natural formative processes in the testicle at the period when the developmental forces are in activity and when morbid products are more prone to be composed of natural structures than they are when occurring at subsequent periods of life. Moreover, the peculiar function of this organ and of the ovary may predispose either gland, under certain circumstances, to the evolution of some structures which, in the natural course of things, should result from the combination of their secretions. The '*hétérotopie plastique*' of Lebert, in other words, the production of these structures by forces existing in the part, is held by pathologists of the present day to be more in

¹ Dr. Van Buren, *Surg. Dis. of Gen. Ur. Organs*, p. 443; see also the account of a paper by the same writer 'On Tumour of Testis containing Fœtal Remains, with a Case,' *Syd. Soc. Bi. Ret.* 1865-1866, p. 331. Dr. Van Buren here removed the left testicle of a child, æt. 2½ years, on account of a tumour which had been thought to be a hydrocele and treated with a seton, but with the effect of causing much suppuration, recurring at intervals, and the protrusion of a fungus about the size of a walnut, and of a very malignant appearance. In a case recorded by Dr. MacEwen (*Glasgow Med. Journ.* Oct. 1878) the patient was a boy of 15. The tumour was noticed shortly after birth, and grew proportionately with the rest of the patient's body. It was oval, smooth, heavy, semi-fluctuating in some parts, hard in others. The skin was not adherent. One large cyst and several small ones were found. Bundles of hair and masses of bone and cartilage were present. One of the bones resembled a fetal sphenoid, and the other a superior maxilla. A somewhat similar case is recorded by Tilanus (*Schmidt's Jahrbücher*, c. 171).

² Velpeau, *Clin. Chir.* tom. iii. p. 198, 1841; Cruveilhier, *Traité d'Anat. path.* tom. i. p. 374, 1849.

³ *Hist. génér. et partic. des anom. de l'organ.* tom. iii. art. Monstres endocymiens; 1836.

⁴ As in M. Velpeau's case which occurred in 1840, and still more recently in that of Dr. Van Buren. Less importance is of course to be attached to older accounts of cases, as these show evidence of descriptions based upon imagination as well as facts.

⁵ As in a very remarkable specimen contained in the series of malformations in St. Barth. Hosp. Mus. Ser. 3368 A. In the anterior mediastinum of a woman, æt. 21, a tumour, probably of congenital origin, contained portions of skin and fat, sebaceous matter, and two pieces of bone, like parts of upper jaws, in which seven well-formed teeth were embedded.

accordance with other teratological and pathological phenomena that the 'inclusion' theory of Saint-Hilaire.¹

(c) The theory based upon Professor Owen's view of partheno-genesis, which is founded upon observation of those aphides who after one impregnation continue to bring forth successive generations; it being suggested according to this view that even in the human body the fœtus when born of its mother may, in exceptional cases, contain within it the germ of another fœtus.

Diagnosis.—This may usually be made by the history, the tumour being usually known to be congenital, by its irregular shape and very varying consistency at different parts, by the escape of greasy fatty material after an exploratory puncture or incision, and by the fact that the tumour possesses characters which are entirely its own, and not shared by any of those which are ordinarily developed in this region.

Treatment.—Extirpation should always be performed. The tumour is not likely to be of malignant nature, nor to be followed by any disease of that kind in other parts. In none of the cases which have been recorded, however, has the sequel been sufficiently given to determine this point. It is quite possible that encephaloid disease may be engrafted upon it, and may have been, in some instances, the cause of a more rapid increase of size. In performing the operation, it should be remembered that the testicle may be free, and that in one case (Velpeau's) it was left uninjured, though the patient died of purulent infection.

CASTRATION.

Having ascertained the absence of any hernia² upon the side to be operated upon, the surgeon grasps the testicle with the left hand and makes an incision, from the external abdominal ring to the bottom of the scrotum, so as to insure free and easy drainage. In cases where the skin is involved by a growth, or ulcerated by a hernia testis, two elliptical incisions should be made, wide of the disease and meeting above and below.³ In cases of any doubt, as where an old hæmatocele may be mistaken for a solid tumour of the testis, the cavity of the tunica vaginalis should next be opened by another incision, and the testis itself examined in order to clear up the nature of the case. It is also well to open the cavity of the tunica vaginalis in cases of a very large tumour, as the bulk may be considerably reduced by the withdrawal of several ounces of fluid.⁴ The scrotal coverings are then quickly shelled off with the right hand, while the testicle is still further protruded with the left. The spermatic cord should now be carefully isolated as high as may be necessary, the inguinal canal being cautiously opened upon a director, if this be needed to get well above the disease. An aneurism needle⁵ armed with a double ligature of stout silk which has been soaked for a quarter of an hour in carbolic acid (1-30) is passed through the cord, the loop of the ligature cut, the needle is withdrawn, and the cord having been thus

¹ Amongst those holding this view are Prof. Humphry; Sir J. Paget (*Lect. on Surg. Path.* p. 446); Mr. Holmes (*Surg. Treat. of Children's Dis.* p. 625); Dr. Payne, Jones and Sieveking's *Path. Anat.* p. 732.

² Sir E. Home (*Obs. on Cancer*, p. 236) relates a case where after the operation had been completed and the wound dressed, a fit of coughing forced off the dressings and caused a protrusion of several convolutions of small intestine, the patient having had a hernia, the descent of which had been prevented by an enlarged testicle. Mr. Curling (*loc. supra cit.* p. 478) mentions two cases of removal of diseased testicles of considerable size, in which, during division of the cord, a hernial sac containing a small piece of omentum was opened, of the existence of which he was not aware. A compress was applied, and both patients recovered favourably. Prof. Humphry, after performing the operation of castration on the dead subject during lecture, found that the lower part of a hernial sac had been removed with the testicle.

³ Where the skin has been much stretched the surgeon may remove some by similar incisions, but, as a rule, this is not called for unless the vitality of the skin is also distinctly impaired.

⁴ Where there are many cysts and softened patches in the line of the incision the knife should be used carefully; a testis which is the seat of soft or rapid growth shells out much more rapidly if its substance have not been cut into.

⁵ No sharp needle should be used in transfixing the cord for fear of setting up phlebitis from puncture of a vein; aided by a finger-nail or a director, the aneurism needle will readily make its way through the cord.

tied in two sections the end of the ligature is cut short.¹ The ligature being thus embedded in the cord substance there is no risk of it slipping, and if it be tied as tightly as possible (the ligatures being tightened up by being looped round two pairs of forceps or scissors) there is no risk of causing the patient any needless suffering.² If it be preferred the vessels in the cord (spermatic, deferential, cremasteric) may be secured by torsion or fine carbolized silk ligatures, but the above method is perfectly safe and much more speedily performed. The cord is now severed half an inch below the ligature, and the diseased testicle removed. Where the operator has to follow up the cord into the inguinal canal, he will bear in mind the existence of the deep epigastric artery. In any case where the cord has been much stretched by a heavy tumour there is additional risk of its becoming retracted into the inguinal canal and into the abdomen, and extra care should be taken to have the cord thoroughly secured before it is divided.³ Owing to the slipperiness of the parts when covered with blood, the cord when retracting may readily evade the fingers of an assistant,⁴ and if grasped firmly with forceps above the point at which it is to be divided there is risk of subsequent sloughing.

A few scrotal vessels, notably one in the septum, may require to be secured, the wound is then closed with silver sutures from above downwards, a drainage-tube having been first introduced and brought out above and below.

During the performance of this operation antiseptic precautions should be made use of in every case where it is possible, and especially in hospital practice. Patients who have to submit to castration are not unfrequently reduced in health, and are thus liable to erysipelas after the operation; a low form of peritonitis also not uncommonly follows, especially where it has been needful to open up the inguinal canal, while if the discharges become unhealthy septic thrombosis is very likely to follow on a wound made in a region so abounding in lymphatics and loose cellular tissue.

Removal of a testis which has been retained in the groin, or which is the subject of malignant disease, has already been fully alluded to (p. 473).

FUNCTIONAL DISORDERS OF THE TESTICLE.

⁵ An interesting and important, though difficult and rarely discussed, point in physiology is the relation of the generative apparatus to the moral character, and the degree in which the former is subservient to and regulated by the latter. I think it would be found that it is so to a very great extent—to a greater extent, perhaps, than is usually recognised; and it is desirable that practical men should pause a while upon a question of this sort, and not hastily commit themselves to opinions which may have much influence upon the well-being and happiness of society. There are no organs so much under control as those of generation. Their functions are neither directly nor indirectly in the least essential to life, scarcely even to the well-being of the body; indeed, which is more remarkable and unusual, they are scarcely essential to the maintenance of the structure of the organs themselves in perfect integrity. The functions of the testicle, like those of the mammary gland and the uterus, may be suspended for a long period, possibly for life; and yet its structure may be sound and capable of being roused into activity. In this respect its qualities peculiarly adapt it for subserviency to man's moral nature. Not that it yields a tame and easy submission. By no means. That stern struggle between the moral and the physical is one of man's greatest trials; a trial which it may be pre-

¹ If the operation is not performed antiseptically, the ligatures should be left long, and brought out at the lower angle of the wound.

² Having seen this method largely used, and having employed it myself in three cases, I am convinced that this statement is correct. Tetanus has been said to follow on ligature of the cord *en masse*. I have been unable to find out whether the cord was transfixed, and whether all possible tightness was used in securing the ligatures.

³ In cases where for any reason an anæsthetic cannot be made use of, the cord should be ligatured and divided before the removal of the testis, as this precaution will save suffering.

⁴ This is aided by the action of the cremaster, which has just been severed.

⁵ This paragraph, and the greater part of the next two, are in the words of Pr. Humphry.

sumption voluntarily to encounter, yet a trial which is, at some time or other, laid upon most men; and it is some satisfaction to know, that if the victory be with the moral, it is not necessarily at the expense of the physical. It is, perhaps, partly with the view of giving strength for this control, or rather, of disarming the antagonist, that the advocates of celibacy among the clergy are usually the advocates also of stringent and regularly repeated fastings.

SELF-ABUSE.

The earliest and most frequent cause of disorder of the generative apparatus is the practice of self-abuse, the tendency to which is strongest about the age of puberty. At that time there is considerable excitement about these organs, increased, perhaps, by the conversation and thoughts which are indulged in; and it is apt to be unchecked by the moral control, which has not yet acquired its proper influence. Moreover, lads are often induced to the pernicious practice by their companions, who may be as ignorant as themselves of the wrong and mischief they are doing. It would be a very good thing if those who have the charge of boys were less scrupulous in giving warning upon this matter. Much trouble and anxiety might be spared by timely advice seriously and kindly given. From no one could this come better and with more authority than from the medical attendant, who often has, or may find, an opportunity of giving a hint in time; and, if I am not much mistaken, his kindness will generally be well appreciated. An extensive acquaintance, through years, with those who have just come from our schools, has impressed the importance of this matter upon me. Often, unfortunately, the habit is commenced at an earlier period than I have mentioned, as early, perhaps, as the age of ten or twelve. At an earlier age children may be led to gradually begin this practice from the irritation of worms, or a long prepuce with retained secretion, and it is to be feared that nurses sometimes, to keep children quiet, resort to means which lead later on to this baneful habit.

A suspicion of the existence of this habit unchecked may be excited by an aspect of languor and heaviness, with progressive wasting and debility, for which no other explanation can be discovered.¹ In boys and older subjects the pernicious effects are evinced *first* in inducing a weakness and irritability in the organs themselves, with nocturnal emissions, or emissions occurring during the day under slight excitement, imperfect or transient erections, premature ejaculatio seminis, &c.; *secondly*, in a general enfeeblement of the frame and disorder of the various functions, in indigestion in some of its many forms, palpitation of the heart, nervousness and impairment of the mental vigour, epileptic and amaurotic symptoms, or even paralysis; *thirdly*, in its influence on the character, in a lessening of the moral courage and the engendering a tendency to shyness, hypochondria, reserve, and solitariness. The mind becomes engrossed with the one subject; and this unfits it for high thought and bold resolve. The man is lowered in his own estimation by the consciousness of yielding or having yielded to a secret habit, and is haunted by the thought of the mischief he has entailed on himself. He seeks the advice of a medical man, yet shrinks from divulging the real cause of his maladies, while he excites suspicion of it by his fidgety absent manner and downward glances.

Two or three points with regard to this subject will now be considered on account of their important bearing on the treatment and management of these patients. The first is that, putting aside such results as chorea, epilepsy, idiocy, insanity, the relation of which to masturbation has probably been exaggerated, there is no doubt

¹ Mr. Holmes (*Surg. Treat. of Children's Dis.* p. 627).

² Mr. Hilton (*Rest and Pain*, 3rd edit. p. 275) has recorded an interesting case of a boy in which trismus and strange contractions of the limbs were the result of self-abuse. Dr. Sayre (*Orthopædic Surgery*, p. 18) relates a case of contraction of the knee-joints from paralysis of the quadriceps extensors, and one of double paralytic talipes equino-varus, both resulting from the morbid nervous irritation due to excitement set up by congenital phimosis and adherent prepuce, and cured by circumcision. For a fuller account of the injuries occurring to the nervous system from irritation of the genital organs of both sexes, a paper by the same author (*Trans. Amer. Med. Assoc.* 1875) may be referred to.

that many of those who grow up unable to throw off that habit by which they have become enslaved, are from the first, if not mentally deficient, at least mentally weak. Another point which the surgeon will do well to remember when a patient comes in gloom or mental distress, because he has occasionally given way to self-abuse, is that self-abuse does not entail, *per se*, as too frequently taught and believed, any especial or terrible injury to the subject of it. It is not for a moment intended to palliate in the slightest degree, or to make light of the unmanliness or self-degradation entailed by the practice when once this is habitual. No doubt this vice when practised frequently, especially by the very young, does entail very baneful nervous shocks from the oft-recurring excitement, but beyond this and the dangerous facilities with which it is practised there is no especial mischief connected with it, and perhaps I may add there is no especial wickedness. And this leads up to another point, the most important of all. It appears to me that the way in which this subject has been tabooed has brought about most pernicious results. I cannot point to more than two or three¹ instances in which the leaders of our profession have boldly grasped this difficulty, and have treated of this subject in a manner which is at once healthy and unshirking. The matter, because painful and most sad, has been thought to be a disgusting one, and it has thus become shrouded in mystery. Until the profession take the lead in putting these matters in a proper light, parents and schoolmasters will look upon children and boys who have fallen into the habit of self-abuse only with disgust, and will always try to conceal and hush up the matter whenever it comes to the surface; while the subjects of it, who might have been broken of the habit if it had been looked upon at the first as a physical failing and not as a hopeless moral degradation, are left to fall later on into the clutches of those vampires who prey upon this, which is almost the saddest weakness of man. The time has come when what is rather a sickly sentimentalism than a true refinement should be laid aside; boys should be taught at what may be a very critical period of their life, that sexual instincts are a part of their nature, and it should be pointed out to them how these, which there is no ignoring or escaping, can be controlled. Too often, however, the boy is left to find this knowledge from others, and in undesirable ways, and happy is he if, before it is too late, he finds in his master² or medical attendant a friendly and judicious adviser. I am firmly persuaded that if parents, or those who are *in loco parentis*, took a healthier view of the sexual instincts, we as medical men should see much less of the results of the sensual passions.

Treatment.—It has been indicated above that this must chiefly be preventive. In the case of a child a careful watch should be kept up during the day, and at night it might be well to adopt some means of fastening the hands. Sources of irritation such as ascarides, retained secretion, and a long prepuce will of course be borne in mind.

It is never desirable to tax a boy who is suspected with the habit. The only result will usually be a falsehood and a further loss of his self-respect. The matter should be talked over in a firm and honest, but friendly way. The boy may be much to be pitied, but he should never be allowed to think himself despised.³

Drugs are useless. Athletic sports, fresh air, cold bathing, simple and nourishing

¹ Notably Sir J. Paget's essay on 'Sexual Hypochondriasis' (*Clin. Lect. and Essays*, p. 268). The subject is also dealt with in a most straightforward manner by Dr. Van Buren (*Surg. Dis. of the Gen. Ur. Organs*, p. 454 *et passim*). Mr. Lawson Tait (*Dis. of Women* Am. Ed. p. 29) also deals with the matter as it relates to girls.

² A tribute may here be paid to the excellent work done by one schoolmaster in this direction. I refer to the Essay on 'Morality,' by Dr. Hime, Head Master of Foyle College, Londonderry. The subject is here treated fully and discreetly, with delicacy and with judgment. While it is especially addressed to young men, all who are brought much in contact with boys will find it invaluable.

³ Mr. Lawson Tait (*loc. supra cit.* p. 30) thus pithily puts the matter: 'I have always found the chief difficulty to be that of persuading those who have charge of schools that the practice was a physical delinquency rather than a moral evil; and that the best remedy was not to tell the poor children that they were damning their souls, but to tell them that they might seriously hurt their bodies, and to explain to them the nature and purport of the functions they were abusing.'

diet, precautions that the boy goes to bed weary and rises early, all these are valuable as aids. Mr. Hilton,¹ speaking of an experience of over twenty years, thought very highly of the plan of blistering the penis, so that it cannot be touched without pain. But this and all other aids will be useless unless the patient himself, from the desire of a higher manliness, endeavour to shake off the habit. It is to be hoped for the future that more sympathy may be shown to foster such desires and more willingness evinced to help such endeavours.

SEMINAL EMISSIONS.

The surgeon is frequently consulted about these. Their occasional occurrence in chaste healthy men is perfectly natural and of no consequence whatever, and the patient may be assured to that effect; but when they return more than once in a fortnight, and especially if they amount to two, three, or more in a week, as is sometimes the case, they should receive attention. Professor Humphry has pointed out that they are much more frequent in the middle and upper than in the lower ranks of life, and especially in those who are of studious and sedentary habits, and are anxious respecting the result of their studies. They are often associated with indigestion and turbid urine. They cause prostration both of body and mind; aching in the lower limbs and back, sometimes a flow of light-coloured urine and irritability of the bladder. They are a source of great mental anxiety. This is increased greatly by the perusal of publications upon the subject, which are freely circulated among young men for the purpose of rousing their apprehensions and inducing them to resort to the authors of these publications, by whom their worst fears are confirmed, and incredible sums are abstracted for promised cure. Hence it is commonly found that to the real effects of the malady are superadded others more or less imaginary, suggested by what has been read, such as loss of memory, inability to fix the mind upon any subject, palpitations, dyspnoea, &c.

Sir J. Paget² has pointed out that emissions occur not only in chaste healthy men with sound nervous systems, but also 'in men with over-sensitive nervous systems, in whom one may believe that at least that part of the spinal marrow which is in nearest relation with the sexual organs is over-irritable. In this condition the emission is apt to take place with much less than the normal amount of excitement. Hence it may take place too quickly during or even before sexual intercourse; sometimes without erection or almost without sensation; sometimes from the mere friction of the dress in riding or walking, or during sensual thoughts; and frequently at night with or without sensual dreams. This if anything might be called spermatorrhœa; but even this is not properly a disease of the sexual organs, it is a disease or disorder of the nervous system, and may most probably be referred, as I have said, to a too irritable condition of the spinal marrow or of some portion of it. For, with the too frequent and too quick emissions, there are always other signs of nervous disorder which, though commonly regarded as due to the emissions, are really not so.

'The chief of these signs are aching of the back and lower limbs, especially after emissions; readiness to be fatigued, and in all fatigue pain; weary limbs and spines; indisposition or seeming incapacity for mental exercise; defect of will and of power of attention; often restlessness at night and unrefreshing sleep; hysteric fits and feelings. Many patients, too, are troubled with palpitation; many with constipation; some with excess of lithates, some with oxalates in their urine; not a few with irritable bladder, some with various nervous indigestions, some with coldness of feet and hands.

'Now, neither these nor any other of the signs commonly enumerated with them are characteristic of disease of the sexual organs; they are signs of a central nervous disorder; they are the very same as are found in many cases of "spinal irritation" and of so-called hysteria in which there is no indications of any sexual disturbance.'

In addition to healthy patients with sound nervous systems, and those whose

¹ *Los. supra cit.* p. 275.

² In the essay above referred to, p. 276.

nervous systems are over-sensitive, there is another class of patients in whom seminal emissions are very common. They are thus well described by Dr. Van Buren.¹ 'Any man suffering from ungratified sexual desire is normally in a condition demanding relief for his over-distended seminal vesicles, and, if that relief is not afforded in some way, it will come spasmodically during sleep. This is all the more certain to be the case if the patient has established a habit of rapid formation of semen by frequent calls for a supply of the same in excessive sexual intercourse, or masturbation practised as a habit for a considerable length of time, and especially if, when natural or unnatural gratification is given up, lascivious thoughts are indulged in, and impure associations continued.'

Treatment.—For this the reader is referred to the next section.

SPERMATORRHŒA.

This term has been extremely abused. It is often applied by patients to the following conditions, viz. seminal emissions which, as shown above, are always to be explained, and which are often natural; escape of mucus, which may be urethral, vesical, or prostatic, and which may point to a relaxed or irritable condition of these parts, but which as a rule contains no spermatozoa whatever, a slight gleety discharge which may be accounted for by the existence of a stricture, or of some inflamed patch on the floor of the urethra, and lastly the term has even been applied to the natural flocculent cloud of mucus which soon makes its appearance at the bottom of healthy urine.

Apart from venereal excitement, fluid containing spermatozoa can only escape when the contents of the vesiculæ seminales which happen to be loaded are pressed out during defecation, especially when there is much straining with solid stools, or when a specimen of urine is examined which has washed out any seminal fluid which may have remained in the urethra after a seminal emission or coitus. But when by repeated venereal excitement in sexual intercourse, and still more after long continued and frequent self-abuse, an irritable, weakened and atonic condition of the vesiculæ seminales, ejaculatory ducts, and prostatic urethra is brought about, emissions are likely to occur frequently and with very slight provocation. The opinion of Sir J. Paget that these too frequent or too quick emissions are due to, and form part of, a generally irritable condition or a disorder of the nervous system has already been alluded to. That this opinion is correct in many cases is shown by the fact that many of these patients show other signs of a defective, weakly or irritable nervous system. On the other hand, it is equally certain that in other cases it is a local condition of irritation which, induced at first by sexual excess of any kind, later on keeps up and intensifies the frequency of seminal emissions. When it is remembered that in many of these patients there is a frequent call to empty the bladder, that tenderness and a feeling of heat are often complained of deep in the perinæum, that the passing of a catheter, however gently, causes pain and perhaps spasmodic contraction as soon as it reaches the prostatic urethra, there can be no doubt that the neck of the bladder and prostatic urethra are in a condition of morbid irritation.

Symptoms.—These need not be further alluded to here. But it should be remembered that these patients, when they come or are brought to the surgeon, are apt, from unwillingness to speak the truth, to refer their complaint to anything but the true cause. Thus in Mr. Curling's² words: 'They complain of indigestion, palpitation, pain in the head and other anomalous symptoms, but neglect to mention the emissions; so that some tact and cautious inquiry are often necessary in order to discover the nature and source of the malady with which they are afflicted. There is something, however, in the appearance and bearing of many of these persons—their shy and furtive glance, pallid and pasty complexion, want of frankness, and incoherent account of their symptoms—which generally enables the practitioner to form a shrewd guess as to the true cause of the mischief.'

¹ *Surg. Dis. of the Gen. Ur. Organs*, p. 460.

² *Loc. supra cit.* p. 459.

Treatment.—The success of this will vary much according to the weakness or strength of the patient's nervous system, the condition of his mind, and the character of his habits. Thus Sir J. Paget, in that essay to which reference has been already made, writes as follows: 'A sensible man, who has been only ignorant on sexual subjects, who can understand evidence and is ready to believe those who are most likely to tell him what is true, will be cured when the truth is told. At the opposite extreme, the worst of the hypochondriacs will be almost incapable of cure: they will believe nothing hopeful; they will be dull to all common-sense statements; many of them will prefer to be guided by rogues rather than by honest men.'

'Between these extremes you will have various degrees of success; and in the vast majority of cases time does good. Some few patients, whose hypochondriasis is a form of inherited insanity, become plainly insane; some, though they marry and have duly regulated sexual intercourse, and may cease to have involuntary emissions, yet retain their other nervous symptoms, and continue hypochondriacal; but the vast majority get well. Some fall in love, marry, and are cured; some, getting into the weighty responsibilities of life, have things to think about more important than their sexual organs, and in all, as they grow older, the spinal marrow becomes less irritable, so that the emissions become less frequent and are attended with less feeling of exhaustion.'

More special directions must be left in great measure to the common sense of the surgeon. Drugs are only of use indirectly. Thus as sedatives, the bromides, *cannabis indica*, *hyoscyamus* may be found useful at night. Indigestion and impaired health may also require appropriate medicinal treatment, but against these, as with sleeplessness, it is best to operate by enforcing matters of common-sense hygiene rather than by recommending drugs, for this course keeps up the idea of invalidism, and leads the patient into an unwise feeling of reliance upon measures which cannot go to the root of the matter.

Far better than all medicines are the giving up of sedentary habits, relaxation from overwork or excessive reading, change of air, travelling, seaside residence, or where the two latter cannot be obtained, athletic sports or open air pursuits of some kind or other, plain unstimulating diet,¹ going to bed weary and getting up when first awaking in the morning. The regular daily bath, tepid at first, if need be, then cold, is to be recommended; a warm bath before going to bed is equally inadvisable. Where there is reason to believe that the patient's fear or misery is due to his having fallen into the hands of those advertising swindlers to whom allusion has already been made, the first effort should be—the patient being first requested to burn any book or pamphlet he may have upon the subject—to restore a calm and less anxious frame of mind, by assuring him that great part of his apprehensions are groundless; giving him good hope of recovery; recommending him to engage in outdoor amusements, and to enjoy the cheerful society of his friends; not to relinquish his reading, but to work less hard at it, especially towards night; to go to bed early and rise early.

A few measures of a more local character remain to be mentioned; such are, removal of an elongated prepuce, and thus preventing irritation of retained secretion; when the patient habitually sleeps on his back, some simple mechanical means may be resorted to to break this habit. It is also well to advise the patient to empty his bladder when first awaking in the early morning, as otherwise that condition of turgescence of the sexual organs which at this time, towards the close of sleep, is not uncommon, is intensified—a result to be especially deprecated in patients who are liable to emissions.

The advantage of local treatment directed to the prostatic urethra has been a good deal disputed. But where there is evidence of local irritability here, as alluded to p. 553, the careful use of a full-sized steel sound, or of a solution of silver nitrate the strength of which is carefully regulated, is often attended with excellent results.

¹ Never perhaps more tersely put than in the saying attributed by Plutarch to Alexander the Great: 'hard marches all night and a small breakfast the next day, *νυκτοπορίαν και ὀλιγαριστίαν*.'—Plutarch, *Apoph.* p. 180, A.

For this purpose I much prefer the syringe-catheter as recommended by Mr. Erichsen¹ to the porte-caustique and the use of the solid caustic as preferred by Lallemand and others. The syringe-catheter consists of a silver catheter with a number of small openings near its end. A small piece of sponge is fixed inside to the end of a stylet. The sponge having been filled with a solution of silver nitrate (gr. v.— $\bar{3}$ j.), and the stylet replaced, the instrument, well oiled, is passed down to the membranous and prostatic urethra. Where the stronger solutions (gr. xx.— $\bar{3}$ j.) or the solid caustic are used, a good deal of smarting, some scalding on micturition, and a slight bloody or purulent discharge are complained of. On this account I prefer the milder solution to begin with, and the above instrument to any other form of porte-caustique, as less liable to cause spasm when passed, or to catch in and produce any slight laceration of the urethra. The application should not be repeated oftener than once in a week or ten days.²

After the use of the silver nitrate the patient should take one or two warm baths, should abstain from much exercise, and should only indulge in bland unirritating drinks.

Where any objection exists to the use of a solution of caustic, glycerine of tannic acid may be used in a similar way, two or three times a week.

Whatever local application is recommended in these cases, it should not be used for more than two or three weeks, as by this time any benefit that is likely to follow will have appeared, and it should only be used for those cases where there is reason for honestly believing that local irritation exists, and that this irritation is keeping up a tendency to emissions.³ In cases, therefore, where we are warranted in considering this part to be at fault, we are justified in applying to it that salt which is often found to allay irritability or a chronic inflammatory condition in other mucous membranes.

The question of marriage is sometimes raised by patients who suffer from sexual emissions and their sequelæ. Where there is much local irritability, where the emissions occur frequently, where the bodily health is poor, and the condition of the mind one of depression, such a step cannot, of course, be sanctioned, as the fruitless attempts at coitus will only increase the local irritation, and still more impair the general health, while the certain failures will intensify the mental misery. Moreover, it is not the health and happiness of one person only that will be affected under these conditions.

When the condition of the mind and body is improved, congenial marriage is likely to be beneficial, as it promotes regular sexual relations, and the maintenance of healthy sexual hygiene.

The operation of castration has been sometimes contemplated in cases where emissions, great sexual excitement, or so-called spermatorrhœa, appear to be leading on to insanity, or to be the causes of epilepsy. The operation is occasionally successful, but more often, as in Mr. Holthouse's case, alluded to below, it does no good. It should be remembered with reference to the operation in these and similar cases, that the fluid emitted is not formed altogether, by any means, in the testes, but merely acquires its fecundating qualities from the secretion of the testes; and that, therefore, the immediate object intended by the operation—the prevention of

¹ *Science and Art of Surgery*, 7th ed. vol. ii. p. 976.

² Mr. Curling (*loc. supra cit.* p. 464) prefers the application of the solid caustic; the cauterisation not being repeated before a month or six weeks. Even in Mr. Curling's hands, however, slight stricture resulted in two or three cases, though this yielded readily to dilatation.

³ Mr. Curling (*loc. supra cit.* p. 457) describes the following appearances which were met with in an aggravated case. They show to what an advanced degree local irritation may extend: 'The mucous membrane of the prostatic part of the urethra was swollen and injected. The prostate was nearly destroyed, and converted into a multilocular abscess, or a number of alveolar cells, communicating with each other; and the diseased mucous membrane covering it was riddled with holes, formed by a considerable enlargement of the original orifices of the gland, through which pus or altered secretion freely escaped on pressing the prostate.' 'One or both vesiculæ seminales were infiltrated with pus, and their walls thickened by inflammation. The orifices of the ejaculatory ducts were enlarged and abraded.'

emissions—really is not effected in many instances, at any rate for some time after the operation. The emissions are not dependent upon the testes, but upon an irritable state of the genital organs; and they may continue, and be as prejudicial, although there be little or no semen in the fluid evacuated.

The following words of Dr. Bell¹ give an estimate of the effect of the operation in these and the allied cases for which it has been proposed:—

‘I have often been consulted as to tying the spermatic arteries, the vasa deferentia, and removal of the testes, in the forms of insanity connected with spermatorrhœa. I have known it done repeatedly. In one case Dr. — castrated a clean-gone onanist, who subsequently rallied, became an active man, and the doctor told me that he never met him that he did not receive his blessing for the great favour that he had conferred on him. In another case of self-perpetrated castration under a similar state of mind, entire restoration to peace of mind and energy was produced. On the other hand, in all the lunatic hospital cases where I have known it done, no valuable results have followed. At the Ohio Hospital, some years ago, it was tried on quite an extensive scale. No case of improvement followed; indeed Dr. Ayl told me that in one patient who previously was quiet and contented, a permanent and dangerous condition of irritability followed.’ These remarks correspond with the result of Mr. Holthouse’s case read before the Medico-Chirurgical Society, March 22, 1859. In that case the epileptic seizures returned as before the castration.

Dr. Bacon,² however, of the Cambridgeshire Asylum, states his belief that in ‘seven of every ten cases of chronic epilepsy in the male sex, the genital organs are the great sources of excitation, and generally from the morbid state in which they are kept by the bad habits of the patients.’ He believes castration to be the only effective mode of quieting this state, and so alleviating the epilepsy and improving the mental condition in some cases, though in others careful supervision and treatment may do much good. Dr. Bacon relates the case of a lad aged 18, in which the operation was followed by marked improvement in health and intelligence, and diminution or cessation of the fits; and he informed Prof. Humphry (eighteen months after the operation) that the improvement has continued, and that since the operation the fits have not recurred with more than a fifth of their former frequency. In another case, that of an idiot, aged 16, with marked sexual excitement, and very frequent masturbation, the removal of the testes eighteen months ago had been followed by great improvement in these respects.

Mr. Chapman³ gives the case of a great sufferer from seminal emissions, with failing health, palpitation, dimness of vision, &c., who had one testicle removed in 1840, and the spermatic artery of the opposite side tied and divided, and more than an inch of the vas deferens removed in 1841, without benefit. Three months after the last operation the remaining testicle was removed. In 1848 he felt himself far better in all respects than before the operation; his eyesight was excellent; but he still was feeble, had weakness in the loins, and was a great sufferer from indigestion and low spirits.

At the commencement of this subject it was stated that the name spermatorrhœa was in every respect a bad one. It is a bad term because, thanks to writers like Lallemand, and others who have too quickly copied his over-drawn picture, and thanks to the too cursory way in which the subject has been treated by most of our chief surgical writers, this word spermatorrhœa has become to the public a term of terror, and yet of mystery, implying as it does to them obscure ‘nervous debility,’ insidious in its origin, but certainly disastrous in its ending. It is even a worse term because it is not only thus abused by the public, but because it has become a source of ill-gotten gain to many a cheat and charlatan. But it is worst of all because no such condition, in my opinion, exists.⁴ And it is for this reason that I have not alluded to those cases, supposed to be typical of spermatorrhœa, which have been

¹ *Boston Med. Journ.* vol. lxi. p. 166, and *Med. Times and Gaz.*

² In a paper on Epileptic Insanity, *Practitioner*, June 1869.

³ *Med. Times and Gaz.* vol. xviii. p. 377.

⁴ The following is Sir J. Paget’s opinion on this matter (*loc. supra cit.* p. 288): ‘First amongst these false teachers is Lallemand. His picture of spermatorrhœa in its complete form is a description of something which I believe to be unknown amongst Englishmen. It may be that there is no such disease in France; a wild imagination may have suggested it; but whether it can be found in France or not, I believe that you will never see it here. I have not yet seen any of the worst cases which Lallemand describes, nor any which would justify the general tone of his descriptions. To many others with as good opportunities as myself for seeing rare and severe cases, they are as completely unknown; and I observe that English writers on this subject, when they wish to tell the worst things to which spermatorrhœa can be said to lead, speak, not from their own observations, but from what they believe to have been Lallemand’s.’

painted in such lurid colours by Lallemand.¹ Apart from nocturnal emissions, there is no such thing as a frequent escape of seminal fluid without the patient being aware of it. Mucous oozings from the meatus there may be, as has been pointed out, of different kinds; hasty premature ejaculations of semen there may be in patients the subject of nervous irritability, or those who habitually have kept their genital organs irritable, by constant sexual excitement of body and mind. Both these conditions may be met with, both are of importance undoubtedly, but they do not authorise the use of a term which is mischievous in many ways. The sooner surgeons drop the term altogether, and speak only of conditions which actually exist, such as seminal emissions, irritability of the sexual organs, &c., the more dignified will it be for themselves and the better for the public.

I cannot do better than, at the close of this subject, call the attention of my readers to the following words of the late Mr. Gascoven,² in which it is most clearly shown that so-called spermatorrhœa is made up of sexual irritability, mental uneasiness, dyspepsia, and hypochondriasis:—

‘When there is much irritability of the genital system, such slight causes as friction of the clothes in walking, of the perinæum against the saddle in riding, licentious talk, indecent pictures, &c., may occasion a slight loss of semen without the usual amount of erection and sensation, often causing the person great alarm and distress of mind, though needlessly. It is not uncommon to be told by a patient of imperfect erection, or even of its complete absence, with a too rapid ejaculation of semen when attempting intercourse, occasioning not only great disappointment and annoyance, but also the most serious apprehension that he is losing, or has lost, his virile power. The knowledge that there is a possibility of failure, together with the shame and vexation of such an occurrence, add much to the probability of non-success when again trial is made; and the loss of confidence thus engendered may really result in a functional impotency, though the structural capacity is adequate for the purpose.

‘When such a condition happens to a person who at some period of his life has indulged in sexual excess or self-abuse—even though many years have elapsed since he practised these habits, and then only for a short period and to a limited extent—he is certain to connect it with his former indiscretions, and to believe that he is permanently injured by them. Or, if it occur to a man who has never in any way abused his sexual power, he will call to mind that in days gone by he occasionally had seminal emissions, and will attribute his failure to this cause, regarding it as evidence of debility, or some defect in his reproductive organs. When once such an idea has crept into his mind, every sensation is eagerly watched for; and the slightest nervous twinge or the least feeling of discomfort in these parts, which formerly would have passed unnoticed, is set down to some abnormal cause.

‘Constant mental uneasiness soon produces dérangement of the digestive organs, heartburn, flatulence, sense of oppression in the epigastrium, swimming of the head, shortness of the breath, loss of appetite, constipation; occasional muscular pains, feeling of general debility, aching of the limbs, and especially of the back, with a host of other uncomfortable sensations, beset the unhappy man, until he believes that he is suffering from the effect of spermatorrhœa, the result of his former imprudence. The more he torments himself about this, the more urgent become his dyspeptic troubles; and unless treated, he gradually sinks into a state of hypochondriasis, passing his time in noting his symptoms, and brooding over them, to the exclusion of almost every other subject. The pain in his loins he attributes to disease of the kidneys or of the spinal marrow; the occasional shooting sensations through the body and limbs to a grave disease of his nervous system; the feeling of oppression in his head, his forgetfulness and mental inactivity, to approaching loss of intellect. He becomes the prey of the most depressing thoughts; and entertains the firm conviction that his condition is incurable, and that idiocy or

¹ *Des Pertes séminales involontaires.*

² In a paper read before the Harveian Society, and published in the *Brit. Med. Journ.* Jan. 20, 1872.

insanity is staring him in the face, until at length he falls into a slough of despond, from which it is very difficult to extricate him.'

IMPOTENCE.

This condition, which here implies inability in the male to copulate, owes its importance to the anxiety and distress with which any diminution in sexual desire and power is usually looked upon. While the above definition of impotence should be adhered to as strictly as possible, it will be found in practice that other conditions, such as absence of venereal desire, are occasionally present, and that occasionally impotence and sterility, or the inability to beget children, run very closely into each other.

The causes of impotence are extremely numerous, and may arise out of any one of the complicated series of conditions which, like links in a chain, are necessary for the due performance of the act, partly voluntary, and partly reflex, of sexual intercourse. The causes are best divided into two heads—those which are physical and often permanent, and those which are due to mental or nervous disorder, these latter being often temporary, frequently exaggerated, and sometimes imaginary altogether.

A. *Physical causes of impotence.*—1. Absence of penis—an extremely rare condition¹ when congenital. A similar condition may result from phagedænic ulceration. Of this I have seen two instances, the penis having been destroyed as far back as the symphysis pubis.² The similar result from amputation needs only to be alluded to. 2. Very small size of the penis, not admitting of sufficient contact with the vaginal walls to produce ejaculation.³ 3. Large size of the penis may also be a cause, but usually only a relative one. This form of impotence is often temporary, the vulvo-vaginal orifice usually yielding to repeated attempts at dilatation. It is noteworthy that this condition may be at the root of much local suffering and mental misery in early married women. It is of course most likely to be met with in those who become wives too early or too late. 4. Extreme degrees of hypospadias⁴ and epispadias, amongst the former being included ectopia vesicæ. 5. Twists and curvatures of the penis. These may be downwards or from side to side. The former may occur congenitally with hypospadias,⁵ or accidentally from opening of an abscess connected with the corpus spongiosum. Lateral twists may either result from previous injuries, as in coitus, which have caused inflammation, cicatricial contraction and atrophy of one of the corpora cavernosa, or from chronic circumscribed thickening in the same situation, often met with in gouty patients (p. 589). This may also produce upward curving of the organ. 6. Abscess and burrowing suppuration in the tissues of the prostate is an occasional cause. 7. A large hernia or hydrocele⁶ or a condition of elephantiasis may be mechanical but remediable causes of impotence. 8. Bilateral syphilitic orchitis and strumous epididymitis have been given as causes, but the correctness of this is extremely doubtful. The amount of fluid emitted in these cases is often scanty, but unless the patient is suffering from great cachexia or phthisis, actual impotence is not present. The testis may present few traces of tubular structure on section, but, as already mentioned (p. 534), discharge of seminal fluid has been noticed from a testis largely disorganised with a protruding fungus. 9. Impotence is known to follow on diseases, such as established phthisis, advanced

¹ Nélaton, *Gaz. des Hôp.* Jan. 1854. Goschler, *Vierteiljahrsschrift für prakt. Heilk.* Prague, 1857.

² A similar case is figured and described *Path. Soc. Trans.* vol. xii. p. 140, woodcut. 12.

³ Roubaud, *De l'Impuissance et de la Stérilité*, p. 160.

⁴ The question of the power of hypospadiacs to have fruitful intercourse may arise in the course of different medico-legal cases.—Dr. Swayne Taylor, *Med. Jurispr.* p. 235. Casper's *For. Med. Syd. Soc. Trans.* vol. iii. p. 249.

⁵ Mr. Bryant (*Pract. of Surg.* vol. ii. p. 163) mentions a case in which 'a man came to ask for castration, as he was unable to copulate on account of the stunted condition of his penis; and the way in which it was held down by a band caused the penis to arch downwards under excitement. He had testitis at the time from ungratified passion.'

⁶ Roubaud (*loc. supra cit.*) mentions a case in which impotency was due to a large double hydrocele, and was cured by tapping. As the sacs refilled the impotency returned.

diabetes,¹ and is occasionally a sequel of the acute fevers. 10. It may occur temporarily with dyspepsia, especially when the urine is found to contain lime oxalate. This has been observed by Dr. Golding Bird,² Dr. Begbie,³ and Mr. Curling.⁴ The last-named writer states that, in examining urine, he has often found that it contained not spermatozoa, but an abundance of octohedral crystals, an indication of impaired digestion, not of seminal waste. In all cases of dyspepsia with impotency, the surgeon should make a careful examination of the patient's urine, and by doing so he will often be able to detect a cause for the weakness quite within the reach of remedies. 11. Certain injuries of the nervous system—blows, especially on the back of the head or cervical spine, are liable to produce impotence. During the meningo-myelitis which follows on the severer forms of concussion of the spine, sexual desire and power are usually greatly impaired, and often entirely and permanently lost. The same is the case in confirmed locomotor ataxy. In cases of recovery after fracture of the lower dorsal and lumbar spine, the genital centre, which, situated in the lumbar enlargement, is largely concerned in erection and ejaculation, is usually disorganised. Where it has escaped, though the genital organs are deprived of sensibility, erection and ejaculation may still take place by means of the reflex mechanism over which the above centre presides.⁵ 12. Of all the drugs which have been said to cause impotence, only the bromides have an undoubted efficacy, when given in twenty-grain doses three times a day. Other sedatives, such as henbane, conium, camphor, have also a temporary, but much less marked, action. Impotence of a temporary kind has been noticed in well-marked cases of lead-poisoning. A more permanent form, there seems reason to believe, accompanies confirmed cases of opium-eating and tobacco-chewing, but in many of these cases the interference with the digestive organs and appetite have to be remembered. 13. Atrophy of the testis with varicocele will be considered later on. 14. Abuse of the sexual functions.

B. Imaginary impotence. False impotence.—Numerous as are the above-given physical and material causes of impotence, the cases in which impotence is due to some mental disturbance or to some deficiency of mental power are more common still. And they are also the more important in that, like some of those already given, they are usually temporary, and admit of remedy, and finally because this mental or imaginary impotence is often a source of much misery and distress, fills the best years of a patient's life with fancied elements of bitterness, and renders him a nuisance to others as well as to himself.

Amongst the causes of imaginary impotence are emotions such as excessive delight, fright, disgust, &c. More frequently the cases of impotence which come before the surgeon's notice are met with in patients of somewhat feeble mind. Such are they who dwell much on past self-abuse, failure to acquit themselves to their own satisfaction on some occasion of irregular intercourse, patients who make much of emissions, which may really not be unnaturally frequent, or who torment and worry the surgeon because they have noticed some prostatic, urethral, or vesical mucus, or who persistently exaggerate a slight varicocele into a hopeless atrophy of the testis. No one can see these patients, often feeble and despondent, over-anxious and over-sensitive, very rarely manly in any true sense of the word, without at once understanding how readily in such cases the capability of sexual intercourse, which requires for its satisfactory performance the co-ordinated and harmonious action of several different parts, may be deficient.

Treatment.—Many of the physical causes of impotence are beyond remedy; others, as will be seen from the above list, admit of obvious treatment, or are of them-

¹ Dr. Willis (*Urin. Dis. and their Treat.* 1839) alludes to the fact, well known at that time, that the sexual appetite generally disappears at a rather early stage of diabetes; and adds that in one of the few cases of genuine recovery with which he is acquainted, the only function which remained in abeyance was the sexual. Dr. Pavy (*On Diabetes*, p. 221) states that as the patient improves with treatment, virility will be found to return.

² *Urin. Deposits*, 3rd ed. p. 231.

³ *Edin. Monthly Journ.* Aug. 1849.

⁴ *Loc. supra cit.* p. 423.

⁵ A case of this kind is quoted by Dr. Brachet, *Rech. exp. sur le Syst. nerv.* p. 280.

selves naturally of a temporary nature. It is the forms of impotence which exist chiefly or entirely in the patient's own mind which come most often for treatment, and which also, it may be added, meet with success at the surgeon's hands, if he can but improve the condition of his patient's mind. Furthermore the subjects of physical forms of impotence which do not admit of remedy are often mercifully wanting, not only in sexual power, but also in sexual desire.

The following decisive words of Sir James Paget's¹ will be found very useful in testing the value of patients' statements on these matters :—' If a man has sexual organs, including the prostate, not manifestly diseased or wasted, and has erections and occasional nocturnal emissions, and any sexual desire, you may be sure that he is not impotent, unless he has very clear facts to prove that he is. The statements that hypochondriacs make to show that they are, or are becoming, impotent are usually evidences that they are not.'

The question of the advisability of marriage is often raised by those who imagine themselves to be the subjects of impotence or diminished sexual power; more rarely, as already stated, by those who are really impotent. This matter is thus well dealt with by Prof. Humphry. 'It is usually necessary to allow a considerable margin for the nervousness of the patient. A quiescent state of the organs, consequent on long control of the passions, is not to be regarded as an obstacle, because they may be roused into activity when appropriate circumstances arise; and after a long continuance and frequent repetition of nocturnal emissions, the organs usually retain sufficient vigour to admit of improvement under the influence of matrimony. It has happened to me often to be consulted on this subject; and I have very rarely felt it necessary to give a discouraging opinion. In the case of one gentleman, who from early life had been subject to very frequent emissions, who had long ceased to have erections or desire, and whom a variety of treatment, including cauterisation of the urethra, conducted by different persons, had failed to give relief, my advice was that he should remain a bachelor. Very soon afterwards he married and had a family. It has been recommended that in doubtful cases the *experimentum* should be made *in corpore vili*. This appears to me to be useless as well as wrong; for the experiment thus made as a test is no real test, and, as might be expected, has ended in disappointment. I know a gentleman, in every respect, as I believe, well qualified to be a husband, and at one time anxious to be so, who has been prevented from marrying by the failure in this test, to which he, most reluctantly and needlessly, assented, in deference to the advice of an eminent surgeon whom he consulted. The indications derivable from external appearance are of little value; and suspicions based upon them have repeatedly proved to be groundless. There are certain obvious disqualifications, such as imperfect formation or diseased conditions of the necessary organs, and an entire absence of erection or desire. Where such disqualifications exist, matrimony is rarely contemplated. Where they are absent, the surgeon is seldom justified in giving an unfavourable verdict; the instances being few in which, by judicious treatment, the patient may not be fitted for matrimony.

'To the encouragement to matrimony it is well to add the hint that though, for various reasons, the rite may not be at first consummated, yet that, in all probability, it will be so before long. This may prevent unnecessary disappointment or despair. I have known premature separation carried out, indeed hurried on by the medical man, when there is reason to think that a little management and patience might have resulted in a happy union. The whole of this question is fraught with so much anxiety and excitement to the person concerned, that the mind is liable to be thrown off its balance, and the most deplorable consequences to ensue. In some cases, doubtless, there is cause for the anxiety; but in many the apprehensions are groundless; and happy is it if a man when thus racked with doubts can bring himself to make a confidant of, and disburden himself freely to, some judicious medical adviser, who will calmly enter into his case and acquire his confidence, who will assure him that such cases are not uncommon, and will, perhaps, give him the often-quoted recom-

¹ *Loc. supra cit.* p. 283.

mendation of Hunter,¹ to make up his mind to abstain for a time, In all such cases it is necessary to take the general state of the health into account ; for any debilitating cause—such as dyspepsia, diarrhoea, mental anxiety, &c.—especially when there are phosphates or oxalate of lime in the urine—is liable to be attended with inability, which may be only of temporary nature, and will yield to appropriate treatment.’

The value of drugs in the treatment of impotence must be briefly alluded to. Phosphorus, cantharides, nux vomica are usually looked upon as direct aphrodisiacs. Of these the first has, I think, no direct value unless given in such large doses as to be risky. It is, however, very valuable indirectly when given in small doses, gr. $\frac{1}{30}$ in pill,² by removing the debility and languor. It is well to combine it with nux vomica. Cantharides is often serviceable in cases where sexual power is deficient, though not entirely absent ; where it appears to be failing prematurely, or after excess. In such cases a combination of tincture of cantharides m xv.–xx. with the perchloride of iron and nux vomica may be tried. But with reference to the above remedies, it must be remembered that their effects are not likely to last after the drugs are discontinued, and that with cantharides in particular, if it fail to render adequate insufficient erections, it will, from the determination of blood to the generative organs which it causes, bring about a morbid and undesirable condition. Where desire is altogether absent, it will not be honest to hold out hopes of benefit from drugs.

Other remedies, as tonics, act indirectly, and to these should be added nourishing diet, with stimulants, the use of exercise in those who find themselves getting stout or flabby, and rest to those whose brains are jaded.

Two local remedies perhaps merit mention—one is the use of mild counter-irritation to the glans penis where this is deficient in sensibility. The other is the use of electricity. Of this mode of treatment, Mr. Curling,³ speaking of the value of passing the interrupted current from the perinæum to the glans penis, states that, though the results are often disappointing, sufficient success has resulted from the remedy to induce him to give it a trial in cases where other means have failed. In some cases of impotency, in which the desires are strong but the erections feeble, the sensibility of the glans is so lowered that the friction of coition is incapable of maintaining prolonged distension of the organ, and erection subsides shortly after penetration. In such cases a few applications of the electric current render the glans penis more sensitive, and in this way cause a more persistent distension of the organ under the natural excitement. This method is perhaps justifiable where other means have failed, and where the patient wishes to submit to it.

It is important to remember that sexual power and desire may fail completely in healthy and in comparatively young men. This form of impotence is not necessarily associated with any discoverable imperfection in the organs, or any obvious defect in bodily formation. Indeed, it may be associated with full intellectual vigour, and a physique, in other respects, sound and strong.⁴ Such cases are, however, rare. The external indications of virility do not often continue when the power is actually and irrecoverably gone.

It seems also that long-continued continence induces an earlier cessation of the capability of function than does moderate indulgence. And after long disuse the attempt to rouse these organs into activity at a late period of life, even if successful, is not altogether without risk to the general health. The excitement consequent on it is liable to induce much prostration, which may be followed by paralysis, amaurosis, affection of the heart, or other disorders. There appears to be some foundation for the remark that these ill-effects are more likely to occur in the case of widowers marrying after a considerable interval than in those who have not been before married. ‘Sexual indulgence late in life seems also to promote the enlargement of the prostate gland ; and I know several instances of old men being attacked with retention of urine from congestion of this organ, occurring after coition.’⁵

¹ *Treatise on the Venereal Disease*, p. 203.

² Some American preparations lately introduced and now easily obtained in this country are excellent.

³ Colles, *Lect. on Surg.* vol. ii. p. 6.

⁴ *Loc. supra cit.* p. 429.

⁵ Mr. Curling, *loc. supra cit.*

STERILITY.

This condition, or the inability to beget children, has been confounded with impotence, or the incapacity for sexual intercourse. The two conditions are distinct, though they may co-exist. Sterility, though its causes and treatment as they arise in the female have been fully discussed, has hitherto received less attention in the male. Mr. Curling¹ has, however, shown the importance of sterility in the male as apart from impotence, by drawing attention to the fact that in women, who are ready for conception, frequent sexual excitement without impregnation may prove very injurious to health, by leading to chronic ovarian irritation, uterine congestion and hæmorrhage.

The causes of sterility in the male are chiefly these:—

1. *Malposition or retention of the testicles.*—This subject has been fully discussed, pp. 465–467.

2. *Obstructions in the epididymis or vas deferens.*—Allusion has been already made (p. 527) to the observations of M. Gosselin upon this subject, and the frequency with which after gonorrhœal epididymitis deposits of an inflammatory nature may form about the tail or head of the epididymis, and, if bilateral, cause sterility. Attention has also been drawn to the great importance of steady and persevering treatment, in order to ensure the removal of such inflammatory deposits. Where such treatment has failed the question of doing something to the nodules by way of operation may be suggested by the patient. The outlook is here not encouraging. Mr. Curling² has performed such an operation without success. Prof. Billroth,³ who considers that these nodules are incurable, never disappearing spontaneously, once operated at the urgent request of the patient, a strong man who had become impotent, the affection being bilateral. The result of the operation was not known. A similar form of sterility will be produced by double tubercular deposits in the vasa deferentia, by congenital deficiency, or interruption of these canals, or by their traumatic severance, as in the case of Dr. P. H. Watson's, alluded to below (p. 565).

3. *Obstructions situated in the urethra, ejaculatory ducts, and prostate.*—A tight stricture may cause sterility, the seminal fluid unable to escape at the right moment, regurgitates into the bladder, and is discharged subsequently with the urine. Mr. Curling concludes that sterility from stricture in the urethra is more frequent than is usually supposed, being in some instances little suspected by the patient himself. 'In erection of the penis the urethra becomes narrowed, so that a stricture which offers but a slight obstacle to the flow of urine may under congestion be sufficient to impede the emission of semen.'⁴

Acute inflammation of the prostate originating in gonorrhœa, and followed by abscesses which not unfrequently riddle the tissues of this organ, may be a cause of sterility.

Mr. Teevan⁵ has met with four cases in which sterility followed the operation of lithotomy, no emission taking place during coitus. The explanation of these cases is not very clear, as it does not appear that the calculi were large ones; but it is obvious that extensive tearing of the floor of the urethra, or inflammation of the prostate after such laceration, might cause occlusion of the ducts.

Another condition exists, which is neither impotence nor one of the ordinary forms of sterility. Thus a patient who has sexual desires and erection finds that the act of coitus, however prolonged, is never satisfactorily completed by an ejaculation of semen, though these, accompanied by the usual orgasm, may take place at other times, as during dreams.

¹ *Loc. supra cit.* p. 451. See also on this subject Dr. West (*Dis. of Women*) and Dr. Priestley (*Med. Times and Gaz.* 1863, vol. i. p. 445).

² *Loc. supra cit.* p. 445.

³ *Clin. Surg. Syd. Soc. Trans.* p. 293. The word impotence occurs several times in the account of this case, probably by mistake for sterility.

⁴ *Loc. supra cit.* p. 447.

⁵ *Clin. Soc. Trans.* vol. vii. p. 179.

The following case, which was under Professor Humphry's care, illustrates this condition :—

A gentleman of spare frame, but enjoying good health and strength, has never been able to effect complete intercourse with his wife in consequence of this defect. Erections occur; but, however long the attempt is continued, emission does not take place. This will, however, often occur afterwards during sleep, and at other times, but is not excitable by the proper stimulus. He was subject to rather frequent nocturnal emissions before marriage. There is no other symptom. A variety of treatment has been tried by myself and others who have been consulted, without avail, such as tonics, with and without strychnine, belladonna, and blisters to the perinæum, the passage of a steel sound, cauterisation of the urethra, and galvanism. I endeavoured also to increase the irritability of the external parts by slight stimulating applications to the glans penis, the perinæum, and the region of the anus.

Dr. Van Buren¹ thus explains the above condition, to which he has given the not altogether well-chosen name Aspermatisms :—

'The theory advanced to account for this strange malady is that, by reason of spasm about the ejaculatory ducts, the semen is prevented from getting into the prostatic sinus. This, however, is untenable; for where there is desire and pleasure, prostatic mucus would be secreted in excess, and would be thrown out by ejaculation while the semen proper would collect and distend the seminal vesicles and ducts below the ejaculatory orifices, and would escape and flow away from the meatus, after the relaxation of spasm, brought about by the fatigue following "half an hour's sexual intercourse." But this is not the case. The fault is evidently in the nerves. There is no pleasurable sensation, no call for secretion of prostatic mucus, or for a supply of spermatic fluid. There is anæsthesia of the prostatic sinus, and although the power of having an orgasm and an ejaculation remains, as proved by dreams, yet there is some connecting link missing in the chain.'

Mr. Curling² mentions a similar case where, though emissions of semen took place at other times, they never followed on coitus. On the supposition that here the nerves of the glans penis were wanting in sufficient excitability, acetum cantharidis was applied to the glans, with, ultimately, entire success.

ATROPHY OF THE TESTICLE.

This may result from a variety of conditions, many of which have already been alluded to. A large number originate in inflammation. Thus atrophy has been noticed after the orchitis of mumps (p. 517), and after extreme congestion of the organ, brought about by inordinate sexual excitement. Another, but far more chronic inflammation of the testis, which may end in atrophy, is the form of diffuse syphilitic orchitis which runs on into cirrhosis of the testis. A less complete form of atrophy may follow on strumous diseases, in cases where the greater part of the testis has protruded as a fungus, and the rest is converted into a mass of quiescent cheesy deposit, or dry calcareous matter.

Although injury to the duct produces no effect of the kind; yet, as we might expect in the case of an organ so peculiarly circumstanced with regard to its circulation, deriving its blood from a long distance through a single channel, and having very few anastomosing currents to fall back upon, it is very sensitive to any impairment of its vascular supply. Thus Mr. Wardrop³ relates that both testicles were absorbed in a man who died of an aneurism of the aorta, obliterating the spermatic arteries; ligature of the spermatic artery will also cause complete wasting of the gland. Varicocele also is sometimes attended with an impairment of the nutrition of the testis; and operations obliterating the veins in varicocele has been known to produce the same result.

In certain affections of the nervous system, atrophy of the testicle has been noticed to occur, *e.g.* after blows on the back of the head and the upper cervical spine, and, more rarely, in cases of recovery with paraplegia from fracture in the lumbar region.

¹ *Surg. Dis. of the Gen. Ur. Organs*, p. 465.

² *Loc. supra cit.* p. 450.

³ In his edition of *Baillie's Works*, vol. ii. p. 315, foot-note.

Atrophy from pressure is here of rare occurrence. It has been occasionally noticed to occur with very large herniæ, in old-standing hydroceles, and hæmatoceles with very thickened walls, and other evidence of past inflammation. More rarely still, atrophy of the testis has seemed to follow upon the pressure of an ill-fitting truss.

In a few cases, as has already been remarked with reference to impotence, the occurrence of atrophy is not to be accounted for. In such cases it occurs prematurely in apparently healthy subjects, and with no preceding history of excess.¹

In other cases the surgeon has brought before him an early arrest of a growing testis, rather than an atrophy of one which has reached its full development. Thus, from time to time, young adults are met with of twenty and upwards, whose genitals recall those of children of four and five. Other signs of virility are here often wanting; a few scattered hairs replace any healthy growth on the face, or pubes, or in the axillæ. The fat plumpness, the rounded outlines, the development of the mammae, and the supra-mammary fat, the width of the pelvis and hips, all recall the female form.

A similar atrophy, and some of the above appearances, are met with in cases of imbeciles, idiots, and occasionally in crétins.

IRRITABLE AND NEURALGIC TESTICLE.

i. *Irritable testis.* About the period of puberty the testicle is frequently tender and irritable, so as to be pained by a slight touch or by the chafing of the trousers in walking. It does not swell or present any indications of inflammation, but it is a source of a good deal of annoyance, necessitating abstention from active exercise and out-door amusement. This condition usually subsides in a short time, and may be relieved by a suspensory bandage, or an evaporating lotion if the part be hotter than natural. The same condition may occur at other periods of life, more particularly in persons of delicate, sensitive and irritable temperament, or in those who have been addicted to self-abuse or excessive indulgence in sexual intercourse. Very often, like irritability of the neck of the bladder, it is due to ill-regulated, unsatisfactory sexual hygiene. A temporarily irritable condition of the testis may be produced at any time in a healthy subject by prolonged sexual excitement ungratified. In such cases the tenderness is especially referred to the region of the epididymis. Sometimes the cause of irritable testis lies in the prostatic urethra and its neighbourhood. To a varying degree it is often present in varicocele. The affection has occasionally proved very obstinate, and has been a source of so much distress to the patient as to lead him to beg for removal of the organ. Sir A. Cooper² was induced by the urgent request of the patients to perform castration in three cases of the kind; and other surgeons have done the same. Such a procedure is, however, warranted only by very exceptional circumstances. It must not be forgotten that the subjects of this affection are from their weakly, irritable, or hypochondriacal minds prone to exaggerate their maladies, and to take gloomy views of their future and of the hopelessness of ordinary treatment. Next to the importance of restoring, if possible, a healthy mental condition by restoring hopefulness and a healthy faith in one case, finding occupation and judiciously regulated exertion in another, enforcing the need of a little healthy neglect of the parts concerned in a third, comes the importance of well-regulated sexual hygiene. Thus in one case absolute continence of mind and body may be necessary for a time; in another, under different circumstances, a happy marriage may be the patient's greatest blessing; in a third the surgeon must look farther afield, and perhaps when his patient's confidence is acquired, he may find that the sickly health of a wife, or some local cause of dyspareunia, may be the cause of irritable testis in the husband.

Sometimes the malady subsides under attention to the general health. It is necessary to inquire into minute particulars respecting the state of digestion, the

¹ Colles, *Lect. on Surg.* vol. ii. p. 6.

² *The Testis*, p. 69. The operation appears to have been successful.

action of the liver and bowels, the character of the urine, the action of the skin, &c. ; for where there is a tendency to irritable testicle, slight disturbances of other organs will induce it. To rectify anything wrong that may be discovered in these functions is the first point. Secondly, it is necessary to improve the general state of the health by out-of-door exercise as far as possible, by moderately nutritious diet, and, perhaps, tonics. Some good may be effected by local applications. Amongst these are cold douches to restore the action of a flabby relaxed cremaster, a suspensory bandage either closely fitting or full sized, so as to allow of encasing the testis in a layer of cotton-wool, or lint spread with extract of belladonna. The liniment of belladonna and a solution of silver nitrate (gr. v.-x- $\frac{3}{4}$ j.) are also useful, but the patient should be prepared for the temporary smarting which follows on the application of the latter.

ii. *Neuralgia of the testis*.—This is a condition in some respects akin to the above. The term should be reserved for cases where severe paroxysmal pain attacks the testis, which is itself healthy, at intervals which may be regular, but more often are not.

The cause of the pain may be in some cases malarial poisoning; in others there is only some disordered state of the health or anæmia to account for it; at times no cause, local or constitutional, can be made out. In other cases irritation or implication of the nerves which supply the cord and testis, or of nerves in communication with them, may account for the neuralgic pains. Thus they have been noticed to occur in cases of renal calculus, or pyelitis; the passage of a calculus along the ureter may excite them, together with contraction of the cremaster. Carcinoma attacking the lumbar vertebræ and involving the roots of the lumbar nerves is another occasional cause. Neuralgia of the testis may be due in some cases to injury affecting the cord.¹ It occasionally in nervous, delicate, weakly patients is associated with varicocele, or with a plugged obstructed condition of the vas deferens. Sir B. Brodie² believed that in one case hepatic disturbance was at the root of the trouble.

In a few cases where this condition follows on orchitis it may be suggested that the nerves of the testis have become embedded in inflammatory cicatricial tissue, somewhat similar to what is known to occur occasionally with bulbous nerves in stumps after amputation. And it must be remembered that in a few of these cases, though here again the testis is not healthy, a small collection of pus, walled in by the substance of the testis, has been the source of the pain.

The pain varies in character and severity, being sometimes dull, at others darting, and so severe as to cause the patient to roll on the floor in agony and covered with perspiration.

The treatment will be the same as for neuralgia in other parts, varying with the exciting cause and the state of the health. When it is periodic, quinine or iron are likely to be beneficial. Where there is evidence of nerve debility and anæmia, phosphorus and cod-liver oil should be tried. Of local measures, the hypodermic injection of a small quantity of strong solution of morphia into the testicle or the tissue immediately investing it offers the best prospect of success, if we may judge from its effects in relieving neuralgia in other parts. Other local applications which may be found useful are ointments or liniments containing aconite and belladonna, or some such preparation as this—aconite liniment $\frac{5}{ij}$, belladonna liniment $\frac{3}{ij}$, mixed with $\frac{3}{ss}$ of glycerine, spread thickly on lint covered with oil silk and worn with a suspensory bandage. Ice used day and night, for two to four days, has been recommended by M. Diday.³ The remarks made above on the reference of the importance

¹ Dr. P. H. Watson (*Edin. Med. Journ.* 1866, vol. i. p. 658) relates the case of a gentleman who became entangled in machinery, one testis being torn away and the other injured. After a while the latter became the seat of intense neuralgic pains, making life miserable. During the operation of castration it was found that the vas deferens had been severed at the time of the injury. The epididymis was converted into a condition of cystic dilatation. After the accident the patient had become entirely impotent.

² *Lond. Med. Gaz.* vol. xiii. p. 620.

³ *Ann. de Derm. et de Syph.* 1869, No. 3, p. 182. The risk of gangrene from such a continued use of ice in weakly subjects has already been alluded to (p. 519).

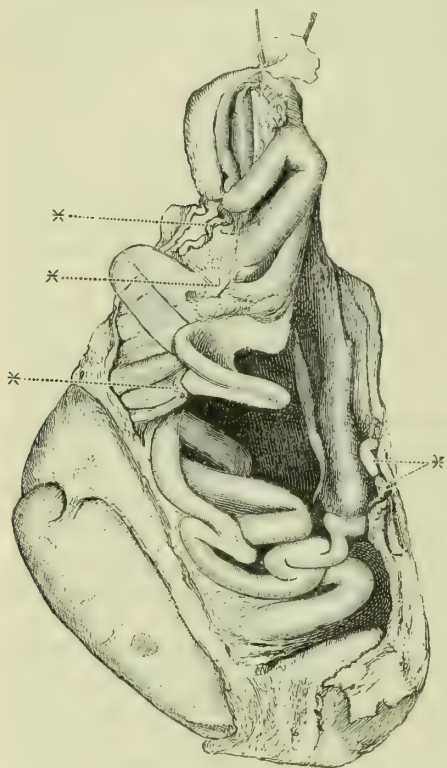
of securing a healthy state of sexual hygiene will also be applicable to many of these cases.

DISEASES OF THE CORD.

VARICOCELE.

This disease consists of a varicose enlargement of the veins of the pampiniform plexus and of those of the lower part of the cord. Including the mild degrees of this affection, which scarcely constitute a disease, it is one of the commonest of the disorders of the male genitals. Prof. Humphry considers that varicocele is met with in about one male adult in ten. M. Landouzy¹ believes that the frequency is far greater, sixty per cent. being, according to him, the proportion of adults affected.

FIG. 113.—Preparation showing Varicocele.
(Guy's Hosp. Museum.)



The asterisks point to numerous small veins, which would have been far more prominent if the specimen had been an injected one. The testis, which is only seen in part, is not wasted.

This statement is, however, an exaggerated one as far as patients in this country are concerned. It occurs much more frequently upon the left side.

Condition of the part.—The veins of the pampiniform plexus are dilated, tortuous, much increased in size, and also in number, owing to dilatation of many smaller veins, and arranged in flexuous curves and loops (fig. 113).

The elasticity and contractility of the coats of the veins are diminished in advanced cases, and here the coats are also usually somewhat thickened; this is generally due to the presence of fibrous tissue of inflammatory origin, and in some cases, in an earlier stage, to compensatory thickening of the middle coat. Thrombosis and phleboliths are frequently present. Even in extreme cases, numerous small and as yet undilated veins (fig. 113) exist which take a material share in carrying on the circulation.

The degree of enlargement varies much. It may be so great as to fill the scrotum and conceal the gland. This is, however, rare. It is greatest near the testicle, diminishes towards the inguinal canal, and ceases in the canal: so that the spermatic vein at and above the internal ring has its natural size.

Condition of the testis.—This point has been a good deal disputed. It is obviously one of importance, for if it could be shown to be the case that serious wasting of the testis is common in varicocele, operative interference would be largely justified. Such, however, is not the case. Save in varicoceles of very large size or rapid formation, serious atrophy of the testis need not be feared in this disease.² There is

¹ *Du Varicocele.*

² Sir J. Paget (*loc. supra cit.* p. 274) writes as follows on this subject: 'Again there are some to whom, whether through ignorance, or misguidance, or hypochondriasis, a varicocele is a source of misery and dismay. They look upon it as a forerunner of impotence, and of wasting testicles, and I know not what besides. All such fears are groundless. Varicocele is troublesome because of the sense of weight and aching which sometimes, though far from always, attends it, and which is sometimes much increased by long standing or walking. In some cases, too, the dilated veins, like varicose veins in the leg, are apt to become inflamed or very sensitive. But this I believe is the widest limit of the harm that varicocele ever

no doubt that the testis on the affected side often feels smaller and perhaps softer than the one on the opposite side. But this, save in the patient's imagination, does not constitute permanent atrophy. It is obvious that if, in a dependent part like the testis, the veins become dilated, the slowly moving venous stream will be at a still greater disadvantage, the smaller vessels will be loaded, the arterial supply will have a difficulty in reaching the smaller vessels, while the blood in the capillaries not being removed and renewed as it should be, the nutrition of the gland will suffer, as evidenced by its losing in part its firmness and plumpness. Where this is very marked and of long duration, true and permanent atrophy of the testis may set in. But that the diminution in size, softness, and apparent loss of plumpness are only temporary, and that they do not, in a very large proportion of cases, lead to atrophy, is shown by the facts that after marriage the testis reaches its former size, the varicocele diminishing, while the patient's anxiety and mental worry disappear also. It has also been observed on several occasions that after operation upon the varicose veins the testis has again become firm, plump, and as large as its fellow.

One more point must be mentioned with regard to this subject. Many of the patients who come with a small varicocele and fancied atrophy or 'dwindling away' of the testis are themselves feeble, delicate, or ill developed generally, not those in whom the usual signs of virility are likely to be well marked.

Causes of varicocele.—Amongst these are the size and winding course of the veins near the testicle; their numerous anastomoses, here and in the lower parts of the cord, which interfere with the efficiency of the valves, and enable fluid injected into them to pass readily from above downwards; the loose inelastic tissue in which they lie affording them little support; their passage through the oblique inguinal canal, where they are frequently subjected to pressure during the action of the abdominal muscles; and the length and comparatively small size of their efferent trunks.

To aid the veins thus placed under difficulties special provisions are made in the presence of the cremaster and dartos to keep the testis naturally supported and duly compressed. But in many of those patients who are the subjects of this affection, these muscles partake of the general relaxation and flabby want of tone.

The following are the reasons usually given for the great preponderance of varicocele upon the left side: (*a*) The slightly lower position of the testis upon the left side, to which may be added the fact that the point of entrance of the left spermatic into the renal vein is upon a distinctly higher level than that of the right spermatic into the vena cava. (*β*) The difference in the manner of ending of the two spermatic veins. Thus the left spermatic usually enters into the left renal at right angles to the latter, and its point of entrance is guarded by a single or double valve. The efficacy of this valve in producing varicoceles has probably been exaggerated. If it were an important factor in the production of this affection, varicocele should be far more frequent than it is, as the opening of the left spermatic vein into the renal, and its orifice guarded by a valve, are constant anatomical conditions. Again, it would be contrary to all the teaching of teleology that an anatomical arrangement such as this should produce and cause a disease. Mr. Gould¹ suggests that the valve at the orifice of the vein may be of use by being partly opened, and in such a manner as to convert the direct aperture into an oblique opening directed upwards and to the right. By thus narrowing the aperture, the aspiration of the blood in

does. I do not believe that it ever produced wasting of a testicle or impotence or any such thing. It is common enough to find varicocele in quite healthy men, who, being sufficiently careless or sensible to make light of it, suffer no harm either mental or bodily. Some who have it while they are single and chaste are cured by marriage; and in some it ceases to cause even its slight occasional aching when they grow old. In short, the cases in which varicocele is more than a trivial affair are very few; and in these few its mischiefs are not such as the sexual hypochondriacs imagine. They are, indeed, altogether distinct from the functions of the sexual organs; being such aching and wearying pains as may be felt in varicose veins in the legs. These may be sufficient to disqualify a man for military service; but they are not sexually important; and in those who believe they are, it is a mental error, not a bodily one, that needs cure.'

¹ *Clin. Soc. Trans.* vol. xiv. p. 80.

the renal vein as it flows over the entrance of the spermatic blood would be increased, and some compensation afforded for the vertical course of the spermatic vein. (γ) The passage of the left spermatic vein beneath the sigmoid flexure, which is so often liable to be loaded. This importance has probably been exaggerated, for, as will be shown below, varicocele usually commences soon after puberty, when constipation is not common.

Of the above reasons the greater length, both at its upper and lower part, of the left spermatic vein, the blood in which already has to contend with so many difficulties, appears to me to be the most important; but even when taken together they seem scarcely sufficient to account for the very great frequency with which this disease is met with upon the left side.

Symptoms of varicocele.—The affection is usually noticed between the ages of fifteen and twenty-five. From its thus frequent connection with the time of puberty, Mr. Gould¹ has suggested the following explanation as applicable to some cases:—‘I would submit that at any rate some varicosities are not the result of a yielding of the veins to internal pressure, but are produced by a primary growth of venous tissue—are, in fact, venous hypertrophies. The normal pampiniform plexus is a striking arrangement, and the developmental activity of the veins forming it remarkable; it surely shows some special tendency to develop veins just at this spot in the embryo. And if so, what more likely to happen than that at puberty, when the testicle is undergoing its full development, or should do so, the veins should again take on the same active growth, and overstep the limit between the normal and the deformed?’

The affection is easily known by the feel of the soft worm-like coils of dilated veins near the testicle and extending to a variable point above it. The scrotum is thin, relaxed, moist, and deficient in the power of healthy corrugation. The swelling is inelastic, increases after long standing, and towards the end of the day, and diminishes in the recumbent posture. It may be aggravated by sudden exertion or straining at stool, by long walking, or standing, or riding.

There may also be a slight impulse on coughing. In these respects, and in its position, it resembles an omental hernia. The feel of the swelling, its slow and incomplete disappearance when the patient lies down, although the inguinal ring is quite free, and its reappearance in the erect posture, although moderate pressure is maintained upon the canal, furnish sufficient means of distinction. The skin is often thin, so that the dark colour and the outline of the dilated veins may be seen through it. The affection is usually devoid of pain and tenderness. Sometimes, especially when it first appears, or when the patient’s attention is first directed to it, it is attended with a sense of weight or uneasiness, or, it may be, actual pain; and it may be tender, and a source of much discomfort. But, as a rule, the degree of discomfort is closely proportioned to the amount of attention which the patient pays to his genitals.² This is certainly the case with a great proportion of the varicoceles which come under notice; and in many of the larger ones the symptoms are inconsiderable when the patient has faith in his surgeon and in simple but efficacious treatment, and also enjoys the blessing of knowing how to judiciously neglect his genitals. In other cases, where the varicocele is very large, the pain is very wearing, both in the testicle and groin and in the back.

Treatment.—This is palliative and operative.

A. *Palliative.*—This will suffice for the large majority of cases, and must be directed to the patient’s mind as well as his body. The honest surgeon will assure

¹ *Loc. supra cit.* p. 82.

² The following remarks of Sir B. Brodie apply both to irritable testis and to varicocele: ‘There is no part of the body in which there are not sensations to be discovered which under ordinary circumstances pass unnoticed. Let anyone think of his shoulder, and he will discover in it sensations of which he would otherwise have taken no cognisance; and if he pays constant attention to them, they will soon amount to pain, so that a patient who has nothing else to do—a low-spirited, hypochondriacal, unoccupied patient—may persuade himself that he has pains in any one part of his body; aye, and that at last he may suffer as much as if disease really existed.’

his patient emphatically that there is no risk whatever of atrophy of the testis or of impairment of virility, and that no operation is required; occupation should be found for the patient's mind and body, attention should be paid to the general health, the bowels should be kept regularly open; the patient should make a habit of taking a cold or chilled bath regularly every morning, and of sluicing the genitals freely night and morning with cold water. A well-fitting suspensory bandage should be worn regularly, and, as Dr. Van Buren¹ tersely puts it, the patient should, 'if possible, forget his sex until an opportunity of marriage affords him a chance to get well.' The remarks made already on the subject of exercise, diet, well-regulated sexual hygiene (p. 554) will, in this case also, be borne in mind.

When the above treatment does not seem sufficient, owing to the increasing size of the varicocele and its painfulness, some support must be given to the weakened veins. This may be attempted by making use of Mr. Wormald's² plan. The patient lying down and the veins being empty, the lower part of the scrotum is drawn through a ring of soft silver padded with wash-leather. The instrument is then compressed, so as to retain it in position, and at the same time cause it to give sufficient support. Sometimes this extremely simple method will be found to give comfort; in others it is difficult to adjust the ring, so as to combine easy and yet adequate pressure; for unless a certain amount of pressure, which cannot always be endured, be maintained, the ring constantly shifts its position, and only adds to the local trouble.

A more readily adjusted, more easily sustained form of pressure may often be afforded by a truss. The object of this is twofold: to give relief which shall be immediate, by taking pressure off the spermatic veins, this pressure being applied over the external abdominal ring, so as to break the long and now weakened column of blood, and prevent any reflux on straining, &c. Another result which may be looked for is, that the vessels, if relieved from pressure for a sufficient time, will recover their healthy state of tone. The pressure may be applied by a truss, in which the pad may be turned inwards by a small ratchet-wheel and key, as recommended by Mr. Hilton,³ for curing sinuses in the groin by adjusted rest; by a moocmain lever-truss, as recommended by Mr. Curling,⁴ who first brought the value of truss-pressure in varicocele before the profession; finally, in a few cases, a small lace-up bag-truss may be found useful. It will be seen that in all these the patient retains the power of adjusting the pressure himself, a point which is of primary importance if the truss is to be a comfort and not a useless nuisance.

A rough but sufficiently reliable test as to the amount of benefit likely to accrue from the use of a truss consists in the application of temporary pressure by means of the fingers over the external abdominal ring while the patient is recumbent and the veins empty, and in ascertaining the amount of relief given when the patient stands up and the pressure is maintained.

As long as the patient retains in one way or another the power of regulating the amount of pressure, no fears need be entertained of atrophy of the testis ensuing from obstruction of the spermatic artery, or complete obliteration of the spermatic veins. Any one who has examined an injected preparation of varicocele will have noticed the number of small veins (fig. 113) which, under duly regulated pressure, will escape complete obstruction and carry on the circulation. With reference to the spermatic artery, it is easily rolled out of the way with the vas deferens, and so is not seriously pressed upon by a truss.

B. Operative, radical.—As already stated, palliative treatment will be sufficient in a large majority of cases, if together with palliative treatment due attention be paid to the general health, the occupation and habits of the patient, and, where this is required, to his sexual hygiene.

Certain cases will occasionally arise in which an operation is justifiable; they are as follows: (a) Where a varicocele steadily increases in size in spite of treatment, and where it is accompanied with much distress, annoyance, and pain.

¹ *Surg. Dis. of the Gen. Ur. Organs*, p. 469.

² *Med. Gaz.* vol. xxii. p. 194.

³ *Rest and Pain*, 3rd ed. fig. 24, p. 160.

⁴ *Loc. supra cit.* p. 500.

(β) Where the patient is precluded from entering one of the public services from which the varicocele excludes him. (γ) Where the surgeon has satisfied himself that the testis is undergoing atrophy. (δ) Sometimes where there are frequent seminal emissions, and much mental distress. In these cases, where the misery is sometimes so great as to endanger the mental faculties, it is justifiable to remove the local source of annoyance and worry.

The choice of operation is a very large one, but the following will be found the simplest, and withal very efficacious.

i. Mr. Erichsen¹ has described a very simple modification of the operation originally introduced by Vidal de Cassis. The vas deferens, readily distinguished by its round cord-like feel, is first separated from the veins and entrusted to an assistant to hold; an incision about half an inch long is then made in the front and back of the scrotum; a needle so threaded with silver wire that the wire will follow without any dragging is then passed between the vas and the veins and brought out behind; the needle is then re-entered and carried out in front, but this time is passed between the veins and the skin, thus including the veins in a loop of wire without implicating the scrotum. The loop is then tightly twisted, so as to constrict the enclosed vessels. From day to day the wire is tightened up afresh, until it has completely cut its way through the veins by ulceration, a process which takes about a week or ten days. Meanwhile there is much plastic matter thrown out around the veins, which finally contracts and obliterates their channels.

ii. The following operation, which is recommended by Mr. Curling,² is a modification of that originally practised by M. Davat and Mr. H. Lee. Mr. Curling has made use of it in nineteen cases, in all with success. With the left hand the vas deferens is separated from the veins, and a straight pin is then passed between the duct and the vessels, about two inches above the testicle, and about three-quarters of an inch below this point another pin is passed in the same way. A piece of card is then applied over the pins so as to guard the skin from ulceration, and a stout silk ligature applied in a figure-of-eight form. The sharp ends of the pins are then nipped off, and the operation is completed by freely dividing the veins subcutaneously with a narrow tenotomy knife by means of a puncture made half way between the pins. Only a few drops of blood usually escape, and a small piece of lint is the only dressing required. The patient is kept in bed, and on the sixth day the ligatures are cut and the pins removed. For a few days more the patient is kept lying down until the wounds have closed, and the tender lump which has formed at the spot operated upon has subsided. Usually the patient can get up in two or three days after the removal of the pins, and go about wearing a suspensory bandage. In two or three weeks the swelling in the cord will have disappeared.

iii. The great risk of all operations performed for obliteration of spermatic veins has been that of fatal septic thrombosis and pyæmia. No doubt this risk will be much lessened by only operating upon patients in a good state of health and by paying great attention to the after-treatment. To avoid it entirely and at the same time to ensure thorough obliteration of the varicose veins, my colleague, Mr. Howse,³ has adopted the plan of antiseptic excision. The operation is performed as follows:—The skin on the affected side having been shaved, the patient being recumbent and under the influence of an anæsthetic, an incision is made for about an inch and a half over the most prominent part of the varicocele, usually beginning about half an inch below the external abdominal ring. Where the varicocele is very large the veins readily bulge into the wound. An aneurism needle threaded with carbolised gut is then passed around the corresponding portion of varicocele above and below, the ligatures are tied and cut short, and the included portion of varicocele is removed with scissors. During this step care should be taken to disturb the areolar tissue and vessels in relation with the vas deferens as little as possible. The spermatic artery which runs very closely in relation with the vas deferens is a small one, and consequently if the areolar tissue about the vas deferens be left undisturbed,

¹ *Science and Art of Surgery*, vol. ii. p. 960.

² *Loc. supra cit.* p. 513, fig. 41.

³ *Guy's Hosp. Rep.* 1877, vol. xxiii. p. 468.

a number of small vessels are left undisturbed and quite sufficient to carry away all the return blood. The small wound in the scrotum is then closed with one or two carbolised silk or silver sutures, and the usual antiseptic dressings are applied, the operation having been performed throughout with strict antiseptic precautions. The wound heals by primary adhesion, the patient is kept in bed for two weeks, at the end of this time he is allowed to go about with a suspensory bandage, and at the end of three weeks he may usually return to his work.

Mr. Howse points out the importance of warning the patients that it will not be till a month or so after the operation that they will experience the full benefit of the operation, as until this interval has elapsed they are still liable to feel a knotted mass along the cord, which results from the healing of the veins and the coagulation of the blood.

Mr. Howse, in the paper to which reference has been made, mentions five cases in which he made use of this method with entire success. I have myself adopted it in three cases. The first patient was incapacitated from his work on one of the railways by reason of a large varicocele which caused great aching in the groin and lumbar region, and was made much worse by lifting heavy weights, &c. As the patient's employment held out very good prospects, he was unwilling to give it up. Three years after the operation I saw him again; he was then employed regularly as a goods-guard, and was able to dispense entirely with any suspensory bandage, the testis on the affected side being then as plump and firm as its fellow.

In the second case the operation was equally successful, and when I saw the patient again, two years later, he had entered the police. The third case was, however, by no means equally successful, and, as such, ought to be alluded to here. The subject of it was a lad who had a double varicocele, that on the left half being of enormous size,¹ this half of the scrotum hanging three inches below that on the opposite side, and the dilated veins extending up to the external abdominal ring. Strict antiseptic precautions being adopted, the varicose veins were exposed and removed between double ligatures. Owing to the large size of the varicocele three bundles of veins were removed, and even then a large number appeared to have been left, the varicocele being now about a quarter of its former size. Throughout the operation the vas deferens and the immediately surrounding tissues were committed to the charge of a reliable assistant, and, being held apart, were not encroached upon. For a week the case appeared to be doing very well, but on the eighth day it became apparent that too many veins had been tied, as the lower half of the testis presented itself at the lower portion of the wound, of a dusky green tint and evidently in a condition of gangrene. A little later this was cut away, a catgut ligature having been first applied. The dressings were never foul, the temperature was rarely above 99°, and no constitutional disturbance was present from first to last; but when the patient went out the epididymis on the left side was found to run into a firm mass, which represented a small portion of the upper half of the left testis.

In this case the operation was carried out precisely as in the other two which had given excellent results. The vas deferens and spermatic artery were certainly not interfered with. The testis itself and the tunica vaginalis were not touched. Nor, as above stated, did it appear at the close of the operation that too many veins had been removed. Such, however, must have been the case.

TUMOURS IN THE SPERMATIC CORD.

Fatty tumours are occasionally found in the cord, and, like the cysts in the same situation (p. 501), being movable to some extent in the course of the cord, they are with difficulty distinguished from hernia. Thus they have the same doughy feel, the irregular outline, and indolent character of an irreducible omental hernia. The nature of the tumour may in most cases be distinguished by the fact that there is usually no upward prolongation into the canal, that it has no impulse when the

¹ This case is figured in Mr. Bryant's *Surgery*, 3rd ed. vol. ii. fig. 385, p. 221, from which some idea of the size of the varicocele may be obtained.

patient coughs, and that it is not influenced by pressure. Two cases which will illustrate the difficulties of diagnosis which may be present in these cases of fatty tumour of the cord, both large and small, are given by Mr. Curling.¹ In one case the growth appears to have been myxolipomatous, as it recurred on several occasions.

Malignant tumours may form in the cord, not only as a sequence of disease of the testicle, but independently of it.²

AFFECTIONS OF THE VESICULÆ SEMINALES.

These have received very little attention from pathologists and surgeons—less than they deserve—for these bodies are not uncommonly diseased in company with the testicles or independently of them; and such diseases may induce or aggravate inflammation of the bladder, and be productive of other ill effects. It is to be observed that the seminal vesicles lie within range of the finger passed into the rectum; so that their condition may, in most instances, be determined with tolerable certainty.³

Inflammation.—This is usually secondary to mischief in the urethra, and is best seen in its acute form after gonorrhœa. The symptoms are now much the same as when the prostate is inflamed, viz. uneasiness about the perinaeum, pain in defæcation, frequent and rather painful micturition or retention, emissions at night, attended with pain, and the fluid stained with blood. The finger in the rectum discovers the vesicle, on one or both sides, distinctly swollen and tender. In two cases of blennorrhagic orchitis, where the patients died of other disease, M. Goussail found the seminal vesicles swollen and gorged. This condition may be so acute as to run on into suppuration, most troublesome abscesses forming and burrowing between the rectum and bladder, and finally leaving most tedious and fistulous tracks. Another troublesome result of inflammation of the vesiculæ seminales is the persistence of a gleet discharge. From the impossibility of getting any local treatment to act directly upon parts so deeply situated, and from the close anatomical connections which the vesiculæ seminales have with the lower part of the rectum, base and neck of the bladder and prostate, it is readily intelligible how very obstinate and tedious a gleet discharge, kept up by chronic inflammation and an atonic condition of these may be, and also how easily irritability of the neck of the bladder and of the sexual organs may be set up. In other cases inflammation of the vesiculæ seminales subsides readily.

The following case of abscess originating in one of the vesiculæ seminales, and proving fatal by extravasation of pus into the peritoneal cavity, is reported by Mr. Mitchell Henry,⁴ and is of great interest:—

A sailor, æt. 20, applied for relief at the Middlesex Hospital for pains in the loins and left hip-joint, and moving like a patient with hip-disease. Examination, however, showing that there was no active disease of the hip-joint, he was sent into a medical ward, on the supposition that he might have disease of the kidney. The symptoms were attributed to exposure to a severe wetting six months before. He had never had gonorrhœa or syphilis, and had usually no difficulty in micturition. There was great pain and tenderness, and shooting pain in the left groin and hip, extending up the loin of the same side, and much increased by any motion of the joint. The patient had a red tongue, great thirst, and quick small pulse. The urine sp. g. 1029 was thick and scanty, loaded with pus, and caused burning pain during micturition. The symptoms were at first abated, but the improvement was only temporary. The pain and tenderness returned, hæmaturia followed, a little later symptoms of peritonitis were noticed, and the patient sank about two weeks after admission.

¹ *Loc. supra cit.* pp. 521, 522. An excellent instance of fatty tumour of the cord, showing how closely it may simulate omental hernia, is given by Mr. Curling, fig. 45. See also a preparation, No. 2461, Hunt. Mus. Here an oval fatty tumour, four inches in length, is embedded in the tissues of the cord an inch above the testicle.

² Hunt. Mus. Preparations, Nos. 2462, 2463.

³ As in Mr. Rivington's case, alluded to below (p. 574). A thesis has been written on inflammation of the seminal vesicles by M. Eugène Rapin (*Mon. des Sci. méd.* 1859, No. 42). See also Canstatt's *Jahresb.* 1860, Bd. iii. S. 284. M. Verneuil (*Journ. de Méd. et de Chir.* Oct. 1874) relates two cases of subacute inflammation of these organs.

⁴ *Med.-Chir. Trans.* vol. xxxiii. p. 307.

Post-mortem examination.—The abdominal cavity contained a large quantity of creamy pus; general early peritonitis was present. The bladder contained purulent fluid, and was perforated by an ulcer as large as a sixpence. The pelvis and the hip-joints, especially the left, where there had been so much pain, were examined, but without throwing light on the presence of the pus in the peritoneal cavity. This was later on explained by the remains of a large abscess being discovered in the position of the left vesicula seminalis, which was nearly destroyed by suppuration. Perforation into the bladder had taken place just where the peritonæum is reflected from this viscus, and thus the pus had found its way into the peritoneal cavity. The urethra and other genital organs were healthy.

A somewhat similar case was communicated by Mr. Cock to Mr. Mitchell Henry, in which it is probable that an abscess formed in one of the vesiculæ seminales, a fatal result having been prevented by a timely evacuation of the pus by an incision through the rectum. Here also the patient complained for some weeks of pain, deep-seated in the lower belly, inclining to the left side and extending around the hip-joint.

Treatment.—Where there is reason to believe that there is acute inflammation of the vesiculæ seminales, absolute rest in bed, occasional warm baths, warm enemata, suppositories, and an early opening through the rectum of any abscess that may form, are the chief indications. Any chronic inflammation that persists afterwards, and any gleety discharge, must be treated chiefly by attention to the general health.

The following conditions, which have been occasionally met with, are perhaps the results of previous inflammatory changes.

Dr. N. R. Smith,¹ of Baltimore, has recorded the following very remarkable case:—

Having been called to a case of apparent retention of urine, he found a large pyriform swelling occupying the pelvis and also the abdomen, reaching higher than the umbilicus, and, on percussion, sounding and vibrating like fluid. An ounce of urine was drawn off by a long catheter. The tumour was clearly posterior to the bladder and displacing it. A vibratory thrill was transmitted from the abdomen to the finger on the rectum. Ten pints of brown serous fluid were drawn off by tapping the swelling per rectum. This was believed to have originated in a distended vesicula seminalis. The patient recovered.

Concretions of a calculous nature² have occasionally been met with in the ducts of the vesiculæ seminales. They appear to resemble prostatic calculi, and to originate in much the same way.

Professor Humphry has in several cases met with a chronic enlargement of the vesiculæ seminales analogous to the affection of the prostate in elderly persons, and attended with corresponding symptoms of irritation of the bladder. He has noticed this condition when examining the rectum under the impression that there was enlargement of the prostate. It was first detected during the dissection of the bladder of an old man who died after long-continued prostatic affection with retention. The prostate was enlarged, and the seminal vesicles were two or three times as large as natural, of very firm structure, so as, in consistence, almost to resemble scirrhus; the component canals were large, and the investing areolar tissue much hypertrophied and indurated.³ At one time Professor Humphry had a man above seventy under his care, suffering under severe irritation of the bladder, amounting to incontinence, in whom the prostate was little, if at all, enlarged; but the seminal vesicles could be felt beyond it of twice their natural size and firmer than usual.

Scrofulous diseases.—The vesiculæ seminales are not infrequently the seat of this affection, and in cases of scrofulous affection of the testicles it is well to examine the state of the seminal vesicles, as they will sometimes be found considerably enlarged and firm, from deposit in their canals, although there may be no symptoms of such a condition.⁴ The changes that take place correspond precisely

¹ *Lancet*, Oct. 19, 1872.

² Beckmann, *Virch. Arch.* Bd. xv. In the *Syd. Soc. Bi. Retr.* 1873, 1874, p. 331, a case is quoted in which, after the passage of a lithotrite for the examination of a bladder, the seat of painful spasm, the patient voided during micturition some small white masses, consisting of an enormous number of spermatozoa. The left vesicula seminalis was hard and swollen.

³ Preparations to show this change, dissected by Prof. Humphry, are in the Pathological Museum at Cambridge.

⁴ The following preparations in Guy's Hospital Museum are specimens of 'scrofulous'

with those that occur in the epididymis: that is to say, the tortuous component tubes become enlarged and distended with serofulous matter, partly infiltrated into the lining membrane, and partly formed of morbid and accumulated epithelium, while the connecting areolar tissue of the tubes remains sound. Subsequently this may be destroyed, if softening and suppuration take place.

The disease is only to be distinguished by examination with the finger in the rectum, and for want of this exploration it escapes notice in many cases. The organ will be found enlarged, perhaps tender, and more or less firm, according to the condition of the morbid deposit in it.

The affection is rarely seen save as part of a more advanced disease in the prostate, bladder, epididymis, or kidney.

Mr. Rivington¹ has recorded the following case of 'tubercular' disease of the left testis and vesicula seminalis:—

A patient, æt. 20, was admitted into the London Hospital with tubercular disease of the left testis. Some months before, this had become swollen and discharged, and had then healed up. Three or four lumps were perceptible in the epididymis. Examination per rectum showed a hardness of the prostate on the left side; proceeding backwards, a hard, cord-like body was detected, similar to a thickened vas deferens; and outside this a more lobulated body, such as would be produced by enlargement of the vesicula seminalis. The patient was also the subject of old hip-disease.

Carcinoma.—This, when affecting the neighbouring organs, may involve also the seminal vesicles.

Atrophy.—Usually the condition of the vesiculæ seminales shows no especial relation to that of the testes. One testicle may be wanting or imperfectly developed, or the vas deferens may be only partially formed, or have been divided, or become obliterated; yet the vesicula seminalis on that side is commonly as large as on the other side. It is in such cases filled with its own secretion unmixed with spermatozoa. This corresponds with the well-known fact that ejaculatory power may be present in persons whose testes are imperfect or absent.

AFFECTIONS OF THE SCROTUM.

Œdema.—The loose tissue of the scrotum renders it very liable to œdema, which is often met with in new-born and young children, resulting in them, commonly, from some slight irritation of the skin, and usually subsiding under careful attention to keep the part dry and powdered. But not unfrequently, in weakly children especially, it passes into a spreading erysipelatous condition, which is frequently fatal. In after life it is easily induced by inflammation or suppuration of adjacent parts, especially abscess connected with the urethra; and sometimes it is the herald of, or attendant upon, general dropsy, resulting from disease of internal organs. It is usually dependent upon some cause, general or local, and subsides when that cause is removed. Great relief may sometimes be afforded, and sloughing of the part prevented, by punctures with a needle at various points; these allow the serum to drain off, and are rarely followed by any of the ill effects which are likely to ensue if incisions be made. The possibility of an open processus funicularis must be borne in mind, and the risk of an inflammatory condition of the scrotum reaching the peritonæum thereby.

Inflammation. Erysipelas.—Its loose structure and pendulous position render the scrotum an easy prey to inflammation, erysipelatous or other, which is apt to be excited by slight causes, such as small wounds or abrasions, boils, or small abscesses in or near it.

Other local conditions occasionally met with are dribbling of the urine, or, as observed by Mr. Liston,² 'sores, or eruptions situated in the groin, genitals, or insides

disease of the vesiculæ seminales —2367⁹⁰, which shows well-caseous masses, and cavities: 2367⁹² and 2367⁹⁸. The prostate and testes were also affected. In two of the cases the patients were 58, and died of general tuberculosis.

¹ *Lancet*, 1872, vol. ii. p. 848.

² *Med.-Chir. Trans.*, vol. xxii. p. 288. *Pract. Surg.* p. 450.

of the thighs, or in fistulæ about the perinæum and anus.' In other cases there is no apparent cause for the attack. In whatever way originating, the affection is a dangerous one. Occurring, as it often does, in patients who are let down in health, intemperate, ill fed, or the subjects of visceral disease, it is very prone to run on into diffuse suppuration and sloughing of the skin and subcutaneous tissue. Another very important point with reference to these cases of erysipelatous inflammation of the scrotum is that they are likely to be mistaken at first sight for cases of extravasation of urine. But that the inflammation depends on some defect of general health or local cause is shown by the facts that the patients have previously to the attack experienced no difficulty in micturition, and that a large catheter can be passed easily into the bladder. When suppuration takes place, it is usually diffuse, and may be recognised by the hard feel and angry appearance of the part, added to the dry tongue and low feverish state of the patient. Abscess is rare in the scrotum.

Preparation 2412⁸⁵, Guy's Hospital Museum, from a patient, æt. 52, under the care of Mr. Birkett, shows that sloughing of the urethra may be caused by erysipelas of the scrotum, without any stricture being present. The patient was admitted with a swelling of the scrotum resembling the effects of extravasation of urine. Incisions were made into this, and it was found that no stricture existed. At the post-mortem examination, the urethra was utterly destroyed for four inches in front of the bulb, the tissues of the scrotum having sloughed down to the urethra.

Treatment.—Where warm fomentations, rest, &c., do not cause a diminution in the erysipelatous swelling, numerous small punctures should be made early. Where the swelling is already great, the scrotum tense and glossy, its tissues and those of the penis brawny and œdematous, where there is any discoloration of these parts, especially when they tend to become ashy grey, incisions must be made freely, and wine, brandy and egg-mixture, carbonate of ammonia, and bark given freely. But, in spite of the above, it is not uncommon for these patients to pass into a condition of increasing asthenia, which finally ends fatally.¹

Gangrene.—The above-mentioned acute cellular erysipelas of the scrotum may soon involve the whole scrotum in gangrene.² The tissues of this region have no great degree of vitality; the arterial branches to it are long and delicate, and, running in loose cellular tissue, which, while it gives them but little support, is readily loaded with inflammatory products, are thus easily strangled.

In other cases gangrene of the scrotum occurs after prolonged fevers; it has also been noticed in children during recovery from one of the exanthemata. It appears to be rare after frostbite.

Treatment.—In addition to the treatment already given, especial attention must be paid to supporting the powers of the patient and carrying him through the process of detachment of sloughs, &c. To secure the latter end, poultices of charcoal or of chlorinated soda will be found useful at first, the gangrenous parts being later on snipped away, and dressings of carbolic oil applied, or some stimulating application, as equal parts of ungt. res. and tr. benz. co. made use of.

The remarkable power of repair which the scrotum possesses, and the way in which exposed cords and testicles become covered in, is well known.

PRURIGO SCROTI.

Under this term three distinct affections have been mixed up, viz. the true prurigo, phthiriasis of the scrotum, and pruritus.

The name prurigo should be reserved for the affection in which solid flattened reddish papules appear upon the skin of the scrotum, which is somewhat darker and thicker than usual, and shows signs of scratching. The affection here, as elsewhere, is extremely obstinate; the causes are obscure, it occurs sometimes in healthy patients

¹ Two fatal cases are given in the *Med. Times and Gaz.* vol. xii. p. 364.

² Mr. Erichsen (*Med. Times and Gaz.* vol. xxi. p. 211) gives a case of acute inflammatory œdema of the scrotum supervening on a perineal swelling, which first appeared during gonorrhœa, and ending in gangrene. The whole scrotum sloughed, laying bare the testicles.

in whom the general health seems satisfactory, though after a time, through the distressing torment caused by the itching, the broken night's rest, &c. the health suffers, perhaps seriously.

Treatment.—This must be chiefly local. The patient must, above all, refrain from scratching the part. The use of strong alkaline solutions—borax ℥ij., acid. hydrocyan. dil. ℥ij., aq. ros. ℥vii. will often give relief. In some cases bichloride of mercury gr. ij., acid. hydrocyan. dil. ℥ij., emulsion of almonds ℥vi. will allay the irritation. Ointments, such as chloroform ℥j., vasel. ℥j.; one containing oil of juniper ℥ij. to ℥j. of vaseline, or the dilute citrine ointment, may also be tried. A strong solution of silver nitrate gr. xx.—℥j. every second or third day will often break the habit of scratching. The patient should avoid stimulating and heating food, heavy clothing, or too warm rooms.

Pruritus of the genitals may depend upon some such local condition as pediculi, eczema, intertrigo, or, without any evident local cause, it may depend, like pruritus elsewhere, on some ill-understood neurosis of the skin.

NEW GROWTHS OF THE SCROTUM.

These are rare. Mr. Curling¹ describes and figures an interesting case of cystic disease of the skin of the scrotum, which he considers analogous to those cystic growths occasionally met with in the lip and cheek. It was under the care of Mr. Crompton, of Birmingham. Occasionally, as elsewhere, the cysts here may originate in sebaceous glands,² or in hæmorrhage. Fatty tumours³ are rather less uncommon, and both are very difficult of diagnosis.

Of *fibrous* tumours several instances have been collected by Mr. Curling; and others have been related. They originate in the areolar tissue, and grow slowly and without pain. Some are very dense, resembling the fibrous tumour of the uterus, and, like it, undergoing occasionally calcification at various parts of the mass; others are more succulent. They may attain to enormous size, weighing twenty, thirty, or more pounds; and have been removed successfully when of this magnitude. Some of the cases have been of the recurrent kind of fibrous or fibroid.⁴

We read now and then of large calculi which have formed in the bladder finding their way into the scrotum, and escaping from it by ulceration,⁵ or being excised.

CANCER OF THE SCROTUM.

This is almost always of the epithelial kind,⁶ and usually confined to chimney-sweepers.⁷ It is much more common in this country than in others, but it appears to

¹ *Loc. supra cit.* p. 583, fig. 49.

² A transparent cyst, the size of an apple, containing unctuous yellowish fluid, situated in the cellular tissue of the scrotum, connected with the skin, and supposed to have originated in the sebaceous follicles of the skin, is described by Dr. Bauchet (*Archives gén. de Méd.* 5^e série, vol. ii. p. 71.)

³ *Trans. of Path. Society*, vol. vi. pp. 230, 232, vol. xvii. p. 176, and vol. xviii. p. 186; Curling, *loc. supra cit.* p. 573; Kimball, in *Boston Med. and Surg. Journal*, Oct. 17, 1861.

⁴ This was so in a case operated on by Mr. Fergusson: a large fibrous tumour was excised from the scrotum; and three years afterwards it recurred, and was of the size of a child's head, involving also the nates. The whole mass was removed. *Med. Times and Gaz.* vol. xiv. p. 166.

⁵ Auvert (*Selecta Præcis Medico-Chirurgicæ*, vol. ii. tab. cxi.) represents and describes an enormous urinary calculus, which began to form when the patient was ten years old, and ulcerated through the scrotum when he was seventy-one. A urinary calculus, weighing 8 ozs., in the Norwich collection, is said to have been removed from the scrotum. A shoemaker had, for twenty years, a stone in the scrotum, which he supported in a pad; at length it got to such a bulk, that, during straining at stool, it ruptured the scrotum and escaped: it weighed 26 ozs. Gräfe, 'Ueber Scrotalsteine,' in *Gräfe und Walther's Journal*, vol. iii. p. 399; Crosse, *On Urinary Calculus*, p. 32.

⁶ A rare case of the growth of medullary cancer in the cellular tissue of the scrotum, involving and requiring the removal of both testes, occurred in the practice of Mr. Craven of Hull (*Med. Times and Gaz.* vol. xix. p. 287). Mr. Curling (*loc. supra cit.* p. 588) mentions one case of carcinoma of the scrotum, and one of melanotic encephaloid cancer.

⁷ Dr. Warren has never seen it in the United States in chimney-sweepers, but has met

be on the decrease here—perhaps owing to the more general use of machines for sweeping chimneys. Thus it is one of the few diseases whose importance may be said to be diminishing. In its origin, structure, course, and implication of adjacent glands, without involving more distant regions, it corresponds with epithelial cancer of the skin in other parts. Thus, it commonly begins in a small soft tubercle or wart on the scrotum, oftenest near the lower and fore part. This tubercle appears to be of simple nature, and may remain for a long time without change, only increasing very slowly. Sooner or later it becomes indurated, spreads, and is covered with a crust; and when the crust is removed it bleeds a little. Subsequently it ulcerates, and an uneven open surface is formed, discharging thin bloody fluid, and having a sinuous edge with a hard tuberculous margin and an indurated base. Other forms in which this disease may originate are hornlike excrescences,¹ and, one more rare but at the same time more likely to be overlooked, as a subcutaneous nodule, over which the skin may be thin and adherent, but otherwise not affected. In such cases as the last, the epithelioma has probably commenced in the sebaceous glands or hair follicles. Finally the affection may start from one of those moles which are met with in the pigmented skin of the scrotum. In whatever way the disease begins, ulceration of a malignant nature is, sooner or later, certain. It then goes on spreading till the whole scrotum is destroyed; and occasionally the crura of the penis and the thickened tunica vaginalis, or even the testicles themselves, are exposed. Before this, however, the inguinal glands usually become indurated. Subsequently they soften and break, forming excavated cancerous ulcers, which spread till the patient is worn out by the discharge and pain. Sometimes a large vessel in the groin is opened, and a merciful hæmorrhage shortens the patient's suffering. After death the disease is commonly found to be confined to the scrotum and groin, and not to have invaded the lumbar glands or the abdominal viscera.

It seems, then, to be quite a local affection, destroying life by the mere tendency to spread at the part primarily affected, and in the glands connected with it; and at first, and it may be for a long time, it often has hardly any of the qualities of malignancy. In one case the surface of the body generally, and of the inner side of the thighs in particular, was covered with small soft cutaneous tubercles, evidently quite of simple character; and the cancerous ulceration of the scrotum had, apparently, originated in one of these. Moreover the ulcerative tendency of the part affected varies a good deal. In some cases it commences before the mass has attained to the size of a shilling; in others the whole scrotum becomes converted into a tuberculated or warty mass, with scarcely any ulceration. Prof. Humphry had one case of the

with it in a few instances in persons not of that business (*Surg. Obs. on Tumours*, p. 329). In a few cases, in this country, it could not be attributed to the contact of soot. That it may be excited in other parts of the body by soot is shown by Sir James Earle's case of the gardener who suffered from the disease in the hand in consequence of his being employed to strew soot every spring for the destruction of slugs (*Pott's Works by Earle*, iii. 182). The hand is figured by Sir J. Paget (*Surg. Path.* fig. 114), and the specimen itself is in St. Barth. Hosp. Mus., ser. xi. Sir J. Paget (*loc. supra cit.* p. 138) speaks thus of chimney-sweep's cancer: 'I suspect that the true influence of the soot in this disease is not that its continued contact determines the growth of cancers, but (at least in part) that it produces a state of skin which provides an apt locality for epithelial cancer in persons of cancerous diathesis. How it does this I cannot imagine; but this is only one of many things unexplained in this strange disease; for the whole of the peculiarities of the chimney-sweep's cancer—its dependence on soot, while coal-dust is wholly inoperative (for the disease is unknown amongst colliers); its comparative frequency in England, especially in certain, but not all, large towns; while in other countries where soot is abundant it is hardly seen; its selection of the scrotum for its most frequent seat—all these and many like facts in its history appear completely inexplicable. Still, it is certain that scaly or incrustated small warts are very common in chimney-sweeps. In many of them, even when they are thoroughly cleaned, the whole skin is dry, harsh, and dusky; and before operation for the removal of scrotal cancers in them, it is a common question whether one or more warts or scaly patches near the chief disease should be removed with it. Nor are such warts confined to the scrotum—they may exist on every part of the trunk and limbs; and I have seen sweeps so thick set with them that a hundred or more might have been counted.'

¹ As in the thick horn-like concretion represented by Mr. Wadd (*Cases of Disease of the Prepuce and Scrotum*, pl. x. and xi.), and by Mr. Curling, *loc. supra cit.* fig. 53

latter kind in which the disease was of long standing, and too extensive for removal, and which terminated fatally. Epithelioma of the scrotum has been met with in boyhood, but is usually seen about middle life¹; and it has appeared in persons long after they had discontinued chimney-sweeping.

Very rarely epithelioma begins primarily in the lymphatic glands of the groin, as in a case recorded by Sir. J. Paget.² But there the patient was a sweep 48 years old, and though there was no appearance of cancer, or wart of any kind on the scrotum or penis, yet, 'his skin was dusky and dry, and many hair follicles were enlarged by their accumulated contents.'

Treatment.—The only treatment is extirpation by caustic or the knife; the latter is much to be preferred. The operation is easily performed while the disease is limited to a part of the scrotum, and good hope of ultimate recovery attends it. Still in several cases the disease has returned, sometimes after a long interval, either in the scrotum or the groin. In such cases the operation should be again performed; indeed, it may be repeated again and again, even though it be necessary to take away the whole scrotum and both the testicles, if there be fair prospect of removing all the disease. When the glands in the groin are only slightly enlarged, they should be left alone for a time, for they may subside or remain quiescent after the exciting cause of their disturbance is gone. If, however, the enlargement is more decided and accompanied with induration, they should be dissected out; and this may be done with very good result; for the disease of the glands is found to be of epithelial character, corresponding with that in the scrotum.

If however the operation is deferred till ulceration of the glands has set in, it will be alike useless and disappointing.

In cases where ulceration of the glands is established, or where the depth of the original disease precludes any hope of a successful operation, the indications are chiefly three—to relieve suffering by subcutaneous injections of morphia and careful nursing, to diminish fœtor by applications such as powdered iodoform, and to support the failing strength.

More rarely carcinoma of the scrotum occurs in the cicatrix of castration. Thus Dr. Moxon³ has recorded a case in which sarcomatous, adenoid, and cartilaginous structures recurred in the cicatrix of the above operation.

ELEPHANTIASIS OF THE SCROTUM.

This is very common in some tropical climates, especially Bengal, the East and West Indies, Ceylon, Egypt, more particularly in the neighbourhood of the Delta, and in some parts of South America. A few cases have been noticed in Europe.⁴ The affection appears to consist primarily of a chronic inflammatory hyperplasia of the cellular elements of the corium and the subcutaneous connective tissue. The areolar tissue is later on hypertrophied, its bundles becoming unusually plentiful and tenacious. Mixed up with these is a large amount of granular molecular material, free nuclei and nucleated cells. The pigment is unusually dark and abundant. The skin and subcutaneous tissue are enormously thickened and infiltrated with

¹ According to Mr. H. Earle (*Med.-Chir. Trans.* xii. p. 299), chimney-sweep's cancer is very rare before thirty, and commonest between thirty and forty. At the date at which Mr. Earle wrote, the employment of children in chimney-sweeping was not legally forbidden.

² *Loc. supra cit.* p. 725.

³ *Path. Soc. Trans.* vol. xx. p. 330.

⁴ In the Museum of King's College Hospital is a specimen of elephantiasis of the scrotum removed by Sir W. Fergusson from a man who had never been out of this country. The mass weighed 5 lb. 15 oz.: the disease was the result of inflammation consequent on a blow. Cases have also been recorded by Liston, *Operative Surgery*; Brett, *Lancet*, July 11, 1846. Cases occurring in other parts of Europe have been related by Delpêch, Lamy, Delmas, Auvert, and Nögell.

In the Museum of the College of Surgeons, No. 2466, is an enormous mass of scrotal elephantiasis, measuring 42 inches in circumference, including the penis and testicles, consisting chiefly of compact structure like mammary gland, and covered with coarse skin, in parts warty and knotty. It was removed by Mr. Liston from a man aged 22, who recovered.

effusions which appear to be of the nature, (α) of simple œdema, (β) albuminous, (γ) fibrinous and lowly organisable. The skin is darker than usual, harder and thickened, sometimes scaly and fissured, but there is not the same tendency to ulceration here as when elephantiasis attacks the leg.

The disease probably commences in attacks of erythematous dermatitis; it is believed that the radicles of the lymphatics are early implicated, then the inflammation extends to the cell-elements of the lymphatic glands, and thus the lymphatic vessels are obstructed and fail to convey away the lymph, which remains behind in the tissues and becomes coagulated, thus adding to the bulk of the tissues and stimulating them to overgrowth. This matter is alluded to again at p. 581, where another explanation of the obstruction of the lymphatics is given.

Symptoms.—As above stated, the disease originates in repeated attacks of a superficial erythematous dermatitis of the scrotum. These, as may easily be imagined, in a warm climate recur frequently, and the part affected remains swollen for a longer period after each attack. After several of these the effusions can no longer be absorbed, and the scrotum becomes permanently enlarged. Patients rarely come for treatment in the early stage. The disease simply goes on increasing obstinately. In the later stages the swelling may reach an enormous size. The penis, drawn down by the scrotum, disappears completely, being deeply embedded in the mass below, the orifice of the prepuce presenting itself as a navel-shaped opening at some point of the anterior surface of the scrotal swelling. By the same tension the pubic skin and hair is displaced downwards. The scrotum itself is replaced by an enormous pedunculated swelling which hangs downwards for a varying length between the thighs or legs, and may even rest upon the ground while the patient is sitting. This mass is attached above by a root which extends from the pubes to the anus, occupying the perinæum. It is doughy to the feel, and painless when handled, the skin having lost its ordinary sensibility. From its bulk it interferes with locomotion, and with the urinary and genital functions. Coexistent with the above affection there may be hydrocele on both sides, and from the constant drag of the mass, inguinal hernia may be present also. Gangrene of these enormous masses has occasionally been noticed.

Treatment.—In the early stages, in which the surgeon is rarely consulted, strapping with ointments containing lead or mercury, pressure applied by elastic tubing, and the use of iodine and tonics internally, have given good results. Later on an operation should not be delayed. In the case of a large tumour, the surgeon must make up his mind beforehand whether he will save the penis or testicles. The patient having been placed on the operating-table, some hours previous to the time of the operation, the tumour should be kept raised by pulleys and supports provided for the occasion. By means of bandages such as those which bear Professor Esmarch's name, every attempt should be made to force all the blood possible out of the swelling. Any hernia that is present should be reduced, and it might be advisable in the case of a huge coexisting hydrocele to diminish the bulk of the swelling by tapping a day or two before. Other means for arresting hæmorrhage which will suggest themselves to the surgeon are clamps made on the principle of ovarian clamps with parallel bars tightened at either end by screws. Mr. Curling has suggested the advisability of passing strong, thick double ligatures through the upper part of the mass by means of needles of sufficient length so as to constrict the base of the tumour temporarily in segments by tying the ends of the ligatures together. This plan appears to have been adopted in one case by Mr. H. Walton¹ with success. Where the patient is advanced in life, flaps of skin having been reflected sufficient to cover the cut pedicle, this might be divided by the *écraseur* and all serious hæmorrhage thus avoided. Dr. Esdaile, whose experience gained at Calcutta is very large—he has operated in 161 cases with a mortality of only five per cent.—states that he never attempts to preserve the testicles where the tumour

¹ *Med. Times and Gaz.* vol. xix. p. 132. In this case the operator tied the scrotum in small segments close to the trunk, removed the mass below the ligatures, and then, as each strangulated part was liberated, the vessels were secured. The tumour was eight or nine pounds in weight. The patient recovered.

weighs over fifty pounds, unless the patient is strong and healthy. The penis was preserved in all his cases save one. Where it is decided to attempt to save the genitals, three flaps of integument must be raised to cover the penis and the testicles. In cutting these the surgeon must be guided by the thickness of the tumour, which may be enormous; the cavities of the tunica vaginalis should not be opened, and the possible proximity of a hernial sac must be borne in mind. The flaps having been raised, the penis, spermatic cords, and testicles should be quickly dissected out and held up out of the way while the pedicle is secured. Unless some of the means above indicated to arrest the hæmorrhage are made use of, copious, and it may be fatal, bleeding will accompany the deeper use of the scalpel; for, it must be remembered, the veins in these cases partake of the nature of large sinuses, and, in spite of dexterity on the part of the surgeon and ready help from his assistants, many of these patients have sunk soon after the operations. The largest which has been successfully removed was one operated on by Clot-Bey,¹ the tumour having weighed 110 pounds, the penis being saved, but the testicles sacrificed.

There are one or two diseases allied to elephantiasis which will be alluded to together in this place; they are lymphorrhagia, 'lymph scrotum,' chyluria.

LYMPH-SCROTUM. VARIX LYMPHATICUS.

This condition appears to depend upon a varicose condition of the scrotal lymphatics. The scrotum is noticed to enlarge and become peculiarly corrugated, studded with soft tubercles,² which discharge from time to time chylous fluid. This fluid is probably a mixture of lymph and chyle. The urine is often simultaneously chylous, and in some cases tumefaction of the inguinal glands has alternated with the appearance of chyle in the urine. If it be granted, as Dr. Carter appears to believe, that in this affection there is a primary change in the lymphatics of the lumbar region, the exact nature of which has not yet been made out,³ but which probably produces an altered state of the vessels, and thus renders their valves useless, it becomes intelligible how chylous fluid, together with lymph, may descend from the thoracic duct, and then, from a giving way of the terminal and very delicate lymphatics, be poured out upon the cutaneous surface of the groin and scrotum, or upon some point of the urinary mucous surface.

With regard to the affinities of this disease to elephantiasis, Dr. Manson,⁴ of Amoy, in a most interesting paper, endeavours to establish the following points:—

A. The generic identity of lymph-scrotum with the ordinary form of elephantiasis. That these are similar diseases, or even the same disease in different forms, is made probable by the following facts. They both attack the same part; they are both accompanied by the same kind of fever and inflammation; they both involve primarily the lymphatics: lymph-scrotum has been found only in countries where elephantiasis is endemic; the course of both affections is similar, and, lastly, they both sometimes occur in the same individual together, or one after the other.

B. The generic identity of tropical chyluria and elephantiasis. This, Dr. Manson admits, is more difficult to establish, but as lymph-scrotum and elephantiasis are certainly closely allied, it is a fair inference that the latter and tropical chyluria are also closely connected. To confirm this, a case has been recorded in which all three diseases, lymph-scrotum, elephantiasis, and chyluria, were all combined in the same individual.

C. The ætiology of these conditions. Dr. Manson believes that they find their explanation in the presence of the *filaria sanguinis hominis* first discovered by

¹ The extensive experience of this surgeon will be found in his *Histoire d'une Tumeur éléphantiaque du Scrotum*, Marseille, 1830; in the *Annales de la Médecine physiologique*, 1834; and in the *Mém. de la Société de Chirurgie de Paris*, vol. iv. p. 547.

² A good illustration of this condition is given by Dr. Carter (*Med.-Chir. Trans.* vol. xlv. pl. iii.)

³ A most ingenious explanation of this by Dr. Manson is given below.

⁴ *Med. Times and Gaz.* 1875, vol. ii. pp. 542, 566.

Dr. Lewis in the blood of a patient in the General Hospital, Calcutta, suffering from chyluria. 'We do not as yet know the seat of the parent parasite, but I suppose it to be on or in the lymphatics, the receptaculum chyli, or thoracic duct, or some blood-vessel in the neighbourhood of these. I conjecture that, as the animal is developed, it becomes surrounded by an increasing tumour, as in the dog; that this tumour (though perhaps a very small one, and easily overlooked in a post-mortem examination), by pressure on the outside, or by bulging into the wall of a lymphatic vessel, causes an obstruction to, or perhaps a complete stoppage of, the flow of lymph. The calibre of the lymphatics, and even of the thoracic duct, is very small, and could easily be obstructed by a minute body. In consequence of this interference with the progress upwards of the lymph, there is accumulation on the distal side of the stoppage, dilatation of lymphatics, perhaps rupture in parts where their walls are very delicate or superficial, as in the scrotum (lymph-scrotum), or bladder (chyluria), or perhaps only stasis and accumulation of lymph materials, which undergo a certain amount of organisation (elephantiasis). . . . After a time the parent nematode dies or escapes, the tumour that enclosed it is absorbed or disintegrated, the lymph-channel again becomes patent, its circulation is renewed, and the chyle disappears from the urine, or the scrotum no longer discharges, or elephantiasis ceases to increase.'

AFFECTIONS OF THE PENIS.

By far the larger proportion of these are, directly or indirectly, connected with and dependent upon gonorrhœa and syphilis; and they, as well as phimosis, paraphimosis, and inflammation of the corpora cavernosa, will be found treated of in the essays on those subjects.

GANGRENE.

The presence of very loose subcutaneous cellular tissue in which the vessels running with scarcely any support are easily strangled by inflammatory effusions and the existence more deeply of a strong resisting fibrous sheath, explain the presence of gangrene in this organ. The moist form of gangrene is more frequently met with than the dry, inasmuch as gangrene of the penis is usually preceded by acute inflammation. The causes are usually local, viz. severe phimosis, with soft chancres and balanitis in broken-down patients, paraphimosis, compression of a ring or ligature, wounds, twists during erection, chordee, urine-extravasation. General causes are more rare, but cases of gangrene of the penis during typhus and typhoid fever are well authenticated; in these cases the gangrene has been of the dry variety.¹

The duration is usually short, the line of demarcation appearing about the tenth day. The prognosis as to recovery must be guarded; as to the future use of the organ the loss of the prepuce is not of great importance; but if one of the corpora cavernosa have perished, the contraction of the cicatricial tissue which replaces it will greatly interfere with erection.

Treatment.—This treatment must be carried out upon general principles. Many local causes admit of immediate removal. Where this is not the case, free exposure of any phagedænic sore, and the thorough application of nitric acid, or acid mercury nitrate, leeches, incisions, warm and soothing applications, or warm irrigations, should be made use of, every means being taken to counteract the asthenia and tendency to depression which are inevitably present in the worst of these cases.

¹ A good instance was recorded by Mr. Partridge (*Path. Soc. Trans.* vol. xvi. p. 192). A man, æt. 40, of temperate habits and healthy constitution, was attacked with typhus fever, became delirious, and remained unconscious for more than a week. When first seen by a medical man the whole penis, as far as its root in front of the scrotum, was gangrenous, with a distinct line of demarcation. The mortified part was black, half dry, like the empty finger of an old black kid glove. The urine dribbled from an aperture between the gangrenous and sound parts. In a few days the mortified part dropped off. The man recovered well. Dr. Murchison mentioned on this occasion that he had met with several cases of mortification of the genitals accompanying typhus fever.

Hæmorrhage is always to be watched for during the spreading of sloughing, and during the detachment of any gangrenous part. Rigors, and other signs of pyæmia, are of course ominous.

If the patient recover, the orifice of the urethra will very likely require attention; in some cases the trimming of redundant skin-covering, where the body of the penis has suffered, is advisable; in others, where the skin has been entirely destroyed, a plastic operation may perhaps be undertaken. Often there is more or less permanent œdema about the remains of the prepuce.

NEW GROWTHS OF THE PENIS.

A few innocent ones, such as warts,¹ nævi,² fibro-cellular growths,³ may here be mentioned, but they call for no special comment, save that the last which are alluded to below, form a connecting link with the sarcomata which occur, though very rarely, in this region.

EPITHELIOMA.

This most frequently begins on the glans, especially at its junction with the prepuce; next to this its most frequent site of origin is upon the inner surface of the prepuce. At first the most usual form is an irregular warty excrescence with a broad and increasingly hard base. After a time ulceration takes place in this, the ulcer having a base with a greyish uneven surface, with hard, irregular, and often everted edges, the outline being sinuous in some parts, jagged in others; the discharge is fœtid, sanious, and thin, instead of well-formed pus. Besides the wart, other forms preceding the hard-based and spreading ulcer are, an irritable pimple, or a localised, slightly indurated, superficially excoriated patch; this is prone to bleed a little, scabs readily, and beneath the scab ulceration advances.

Epithelioma may extend from the scrotum on to the penis, and in one or two cases it has been known to commence on the floor of the urethra.

In whatever way it commences, ulceration, if left to itself, extends backwards towards the root of the penis, scrotum, and perinaum. The corpora cavernosa are seen on section to have lost their characteristic appearance of spongy erectile tissue. This is replaced by greyish material, somewhat dry and friable. Farther back, even where, at first glance, the tissue of the corpora cavernosa looks natural, little rounded grains of a similar greyish colour are, on more careful examination, seen scattered here and there. On pressure the above may be squeezed out as little pellets of epitheliomatous tissue. The bearing of this point on amputation is obvious.

¹ Warts should always be destroyed early when in this situation. In later life they tend to take on a malignant action, and in earlier life a wart on the prepuce, which is non-venereal in origin and quite devoid of secretion, may, under the effects of irritation, as after marriage, cause a copious crop of warts upon the female genitals.

² These should of course be destroyed early. They are usually cutaneous, but occasionally implicate the glans deeply.

³ A good instance of this form of a growth is recorded by Mr. Hutchinson (*Path. Soc. Trans.* vol. vi. p. 228). Here the patient was a boy, æt. 8; enlargement of the end of the penis had been noticed only about ten weeks, though it latterly was increasing fast, and had on several occasions caused retention of urine. On slitting up the prepuce, which was in a state of irreducible phimosis, a well-defined fibrous tumour was found attached by a broad base to the corpora cavernosa, just behind the corona. To avoid injuring the penis, this base was cut through, no attempt being made to enucleate. Five months later there was no evidence of any recurrence. In this case there was a doubtful history of an injury. Mr. Beck (*Path. Soc. Trans.* vol. xxiv. p. 153) records a case of fibrous tumour of the penis. This came first close to the base of the glans, and was removed. Two years later it recurred in the cicatrix. It was about the size of a hen's egg, irregular, nodular in shape, excessively hard, and free from pain or tenderness. It being impossible to remove the growth without seriously injuring the penis, this organ was amputated. On examination, the growth sprang from the corpus cavernosum, and it was evident that any operation short of amputation would have been followed by a second recurrence. Microscopic examination showed numerous oval nuclei, indicating a state of somewhat rapid growth.

As a rule, the urethra remains but little encroached upon, though its orifice in the midst of cancerous vegetations may be hard to find. More rarely it is so narrowed or invaded by the growth that fistulæ form farther back.

A far graver propagation of the epithelioma is that to the glands in the groin. The rapidity with which this takes place is variable. It appears to depend on two points—the amount of exposure of the original lesion on the penis, and the rate at which ulceration takes place in it. With regard to the influence of the first, just as an epitheliomatous ulcer of the tongue, constantly kept moist and warm, spreads more rapidly and invades the lymphatic glands more speedily than a similar ulcer on the prelabium, which is more exposed and thus dries more readily, so an epithelioma of the penis starting on the inner surface of the prepuce or on the corona, where the secretion will be retained and the moisture will favour rapid ulceration, will invade the lymphatic glands more quickly than one situated from the first on the more exposed glans. And the same may be said of phimosis in bringing about rapidity of lymphatic invasion. But the rate at which ulceration of the epithelioma extends is a more important factor. As with other epitheliomata, epithelioma of the penis is so prone to ulceration that it often is not brought before the surgeon's notice till it shows a good instance of what may be called a 'malignant ulcer,' which increases persistently as its base and margins, consisting of neighbouring parts infiltrated with cancerous deposit, steadily break down. The glands are at first swollen, not very hard, and not adherent, on section soft, succulent, and pinkish-grey. Then they become harder, more adherent to one another and to the surrounding parts, and so more lumpy and massive. On section they now show a thickened capsule, some remains of gland-tissue around an opaquely white evascular centre, which will, before long, break down and come away as a grumous semi-liquid substance.

As was the case with the original ulcer, inflammation is sure to attack these glands. Suppuration now aids the discharge of their centres, the glands become more and more caverned out, and the groins may thus show ulcers as malignant and progressive as that on the penis.

Diagnosis.—This is not easy in the early stages. The surgeon may be called upon to give an opinion as to the innocence or malignancy of three separate conditions at least, viz. : (α) indurated matter or nodules beneath the mucous membrane of the prepuce and perhaps occurring at the site of a primary sore ; (β) ulcerations ; (γ) vegetations and warts.

(α) Stony hardness, early ulceration, ragged and warty edges of the ulcer, much pain, distinct enlargement of the inguinal glands, all point to epithelioma.

(β) Where an excoriation at first diffused and shallow extends in width and depth ; where an ulcer shows, in addition to deepening excavation, marked induration of base and borders, a base unequal in depth, and uneven or warty ; where an ulcer bleeds readily, and in the intervals of hæmorrhage yields a thin ichorous offensive fluid prone to scab ; where the edges are raised, uneven, everted, and undermined ; where many of these conditions are present, malignancy must be suspected.

(γ) Ordinary vegetations and warts are often very hard to distinguish from papillary or warty epitheliomata. The presence of deep clefts between the masses of papillæ ; the presence of constant moist ichorous discharge from these clefts, readily scabbing and concealing ulceration of the above character beneath, are suspicious of malignancy.

Causes.—1. *Age.*—This appears to be indirectly a cause of cancer of the penis. Thus it is rare before 45, chiefly met with between 45 and 70.

2. *Phimosis.*—The fact that this was a predisposing cause was long ago pointed out by Hey,¹ who, in twelve cases of epithelioma of the penis, found phimosis in nine. The influence of phimosis is manifold ; thus the products of the sebaceous

¹ *Pract. Obs. on Surg.* 3rd ed. 1814. M. Demarquay (*Mal. du Penis*, p. 388) tabulates fifty-nine cases of epithelioma of the penis, in forty-two of which there had been a preceding phimosis.

glands become retained and decomposed; an additional source of irritation is present in sexual intercourse, and in the obstacle which is presented to the free flow of urine at every act of micturition.

3. *Venereal disease*.—This may predispose to epithelioma in different ways—(a) in the production of warts, which are kept moist by the prepuce, and are constantly liable to irritation; (β) by leading to the formation of chancres, whether hard or soft, especially if acquired towards middle life, and if of any duration, or if exposed to irritation and not subjected to treatment; (γ) by the scar of a chancre. This may be a source of long-continued local irritation, leading later on to epithelioma. Of this the following is an instance:—

A gentleman,¹ æt. 69, died of epithelioma of the penis, Sept. 3, 1865. When 35 years old he had a chancre, which healed up under mercury, but left a scar, which was visible for some time after. Seven years before his death he noticed some redness in the locality of the scar. This redness subsequently became a sore surface, which extended from time to time, and then healed up. Five years before his death there was on the right side of the glans penis a patch of redness, the surface being raw, as if denuded of epithelium. The red patch was circular, and surrounded by a zone of brighter redness. There was slight irregularity of surface, but no induration. The following year the patch became distinctly warty. A portion was destroyed with glacial acetic acid, and healed up, but fresh warts formed at the side. Three years before his death the glands in the right groin became slightly indurated. It was not till a year before he died that any induration was observed beneath the sore. At first this was very limited, but by degrees nearly half the glans penis became hard and solid. This condition then extended along the body of the penis, and ulceration took place both here and in the glands of the groin.

(δ) By some patch of tertiary induration of the cellular tissue of the foreskin.²

4. *Wound or laceration*.—Thus a tear of the delicate skin of a naturally too short frænum, constantly subjected to irritation and never satisfactorily healed, may ripen into an epithelial ulcer and epithelioma.

5. *Contusion*.—A case in which a rapidly growing malignant growth of the penis, not an epithelioma, but probably a sarcoma, was started by a contusion, is alluded to below.

6. Quite a different way in which epithelioma may occasionally invade the penis is by starting in the irritation of an urinary fistula. Very rarely it begins in the urethra,³ originating in irritation of a stricture.

Other forms of malignant disease of the penis.—These are extremely rare. Mr. Holmes Coote recorded⁴ a case of primary cancerous infiltration of the penis in a patient, æt. 55.

The corpora cavernosa were distended to their uttermost by the infiltration of a semi-fluid, creamy deposit; this fluid exuded from the cut surface as a thick juice, and under the microscope was held to contain nucleated cells, mostly elongated and candate, very similar to those deposited in scirrous cancer of the breast.

With this condition of things, secondary deposits were found in other parts of the body. Dr. Weir,⁵ of New York, has recorded a somewhat similar case where rapidly growing malignant disease of the penis, occurring in an unusually young patient, destroyed life in eleven months.

C.C. æt. 18 had four months previously slipped on a ladder, bruising his penis between a rung and the pubes. The patient was in good health at the time and there was no hereditary history of cancer. The injury was followed by some ecchymosis, and much swelling and soreness; no bleeding was noticed from the urethra. The swelling increased steadily, the

¹ This case will be found reported by Mr. Sibley, *Path. Soc. Trans.* vol. xvii. p. 177.

² *Path. Soc. Trans.* vol. vi. p. 229.

³ There is a specimen, No. 2412¹⁰, illustrating this point in Guy's Hospital Museum. The patient, a man, æt. 55, was admitted under my colleague, Mr. Howse, for supposed stricture. It proved to be a case of primary carcinoma of the urethra, a fungating ulcer, 2½ inches in length, being found in the floor of the urethra, with rounded masses growing into the substance of the penis. Some of the lumbar glands contained cancer.

⁴ *Med.-Chir. Trans.* vol. xxvii. p. 1.

⁵ *Am. Journ. Med. Sci.*

penis being tense and continually erect. Since the third week pain had been persistent, worse at night. Micturition had latterly been interfered with. *On admission* the penis was much enlarged, measuring $5\frac{1}{2}$ inches in length, and the same around the glans. Skin normal. The growth did not extend beyond the root of the penis, being apparently confined to the corpora cavernosa, which were tense and elastic from thinning of their sheath. The cutaneous veins were much enlarged, and the whole organ visibly pulsated. The glands in the right groin were enlarged, one of them, the size of a pigeon's egg, being tender and bluish. Those on the left side were also enlarged, to a less degree. Considerable relief was given to micturition by slitting up the prepuce and performing external urethrotomy, but the penis and glans went on swelling, and a soft fungous easily bleeding mass which sprouted from the corona grew rapidly. The patient was removed home by his friends, and died seven months later, the end being hastened by hæmorrhage which followed on an incision into the enlarged glands in the right groin. No *post-mortem* or microscopic examinations appear to have been made. The whole duration of the disease appears to have been eleven months.

Treatment.—Any suspicious excoriation, ulceration, or wart, should be early destroyed with nitric acid or the acid nitrate of mercury. Where, after this treatment, satisfactory healing does not take place, early and thorough removal of the part should be performed. There should be no dangerous waiting because the surgeon is unable to satisfy himself whether the case is one of inflammatory induration or infiltration from new growth. In such cases, especially where there is a doubtful history of syphilis, much valuable time has been often lost in the exhibition of drugs which, even if the lesion does date back to some long-past syphilis, are quite useless if epitheliomatous ulceration has set in. Furthermore, the longer ulceration continues the more extensively will the inguinal glands be involved. As long as these are involved only by growths, hard and separate from each other, careful dissection will often succeed in shelling them out, and thereby in adding materially to the prolongation of the patient's life. But where they not only contain secondary deposits, but also inflammatory matter, owing to the ulceration having set in at the seat of primary lesion, it becomes a matter of great difficulty, and it is often impossible to satisfactorily remove the glands, owing to their softness and tendency to break down under the finger, their adhesions to their capsules, and the matting of these to the surrounding parts, which are very vascular, and in the case of the overlying skin often implicated and adherent. In such cases, though the penis may be satisfactorily operated upon, disappointment will speedily follow, owing to the outbreak in the inguinal regions. It may be added that scarcely any surgical case presents a close more distressing both to the patient and those around him than one of secondary epitheliomatous breaking-down of glands, owing to the hideous ulceration, the noisome discharge, and the steady decay of bodily strength. When the disease commences on the glans, it may still be possible to remove the affected part without destroying the whole of the glans, or interfering with the urethra. It seldom happens, however, that we see the case sufficiently early for this; and it is usually necessary to remove the whole of the glans and more or less of the corpora cavernosa. Before doing this, the prepuce, unless it admits of being retracted, should invariably be laid open, so as to expose the growth, and make quite sure of its real nature. The operation of amputation may be effected by a single sweep of the knife, the skin having been previously drawn a little forward, to prevent there being a superabundance of it afterwards, and a clove-hitch of tape adjusted, if one of the clamps which bear Mr. Durham's and Mr. Clover's names cannot be made use of. A good deal of bleeding ensues, the blood pouring out from the whole divided surface of the corpora cavernosa, as well as from the dorsal arteries. The latter should be tied first; then the larger vessels upon the rest of the stump; and the numerous smaller vessels will close spontaneously after a few minutes. The dread of the bleeding has induced the occasional resort to the galvanic *écraseur*. That, however, is not a sure preventive; for sharp hæmorrhage has followed a few hours after the operation, or later on during the detachment of sloughs, and it leaves a more sloughy and troublesome wound than the knife. This may be a matter of but slight importance in patients who are comparatively young and robust, but where, as frequently happens with these patients, they are advanced in years, pulled down in health, and often depressed in mind, tedious healing of the wound, which it is

difficult to keep sweet, involving, as it does, a prolonged keeping the patient on his back, is not a slight matter. The stump will granulate and heal spontaneously, the skin closing over the face of it, and becoming puckered to a narrow circle surrounding the urethral orifice. The real, indeed usually the only, difficulty in the operation and subsequent management is caused by the tendency of this circle to contract, more and more, so as to narrow the orifice and interfere with the passage of urine.

The following method of amputating the penis is followed by rapid healing, and gives an excellently covered stump. A flap of skin is cut from the dorsum and sides of the organ, and the dorsal arteries are secured. This flap resembles, in miniature, an anterior cutaneous flap in amputation of the thigh. The knife, a narrow-bladed one, is then inserted at a point on a level with the base of the above flap, between the corpora cavernosa and the corpus spongiosum, and then is made to cut forwards, outwards, and downwards for about three-quarters of an inch. From this smaller posterior flap the urethra is dissected out. The corpora cavernosa are then divided vertically upwards on a level with the point of the transfixion. All hæmorrhage being arrested, the upper flap is punctured at a point opposite to the urethra and the corpus spongiosum, drawn through the face of the flap, slit up and stitched, as in any other mode of amputation. The two flaps, upper and lower, are then joined by one or two points of suture.

This method secures a natural skin-covering for the severed corpora cavernosa, and prevents the delay and irritation, which the healing by granulations of these bodies entail. A somewhat similar method was long ago suggested by Prof. Miller,¹ but according to the method of this surgeon, the flap was cut from below. If, as recommended above, it is made from above, it will be found that the skin falls more readily, and keeps its position better, over the raw surfaces of the corpora cavernosa.

Passing of catheters should, as far as it is possible, be avoided. It is extremely painful, and delays the healing. Slitting up and stitching the urethra will usually obviate any such necessity.

Occasionally where the glands are not enlarged, and where the local mischief is very extensive, the surgeon will be forced to undertake far severer operations. Thus Mr. Annandale² has recorded a case in which he successfully removed penis, scrotum, testicles, and supra-pubic skin, for epithelioma; there the disease had begun in the usual way, in the extremity of the penis, and in the course of four years had gradually implicated the surrounding parts. One or two glands were slightly enlarged in the right groin, but this appeared to be the result of simple irritation, and was only of recent origin.

Where the penis is involved as far back as the scrotum, the entire organ, including its crura, should be extirpated, if the glands in the groin are not involved. The patient, being in the lithotomy position, the scrotum is to be deeply split along the whole length of the raphé, and the corpus spongiosum carefully dissected out. This step may be facilitated by passing a large metal sound. When the triangular ligament is exposed, the above instrument being removed, the corpus spongiosum, which has been dissected out, should be cut through, and left long enough to bring out in the perinæum. By means of a raspatory, or blunt dissector, the crura are then detached on either side from the pubic arch, and the incision being prolonged around the penis above, the suspensory ligament is divided, and the dorsal arteries secured. The cut end of the corpus spongiosum is now slit up and stitched to the posterior part of the scrotal incision, and all the rest of the wound closed with silver stitches. Any ligatures which have been used should be left long and brought out at the posterior margin of the wound, and if this does not seem likely to provide for sufficient drainage, a piece of tubing of appropriate size may be passed from above downwards. Similar operations to the above have been performed on several occasions, but the important modification of dissecting off the crura, and thus

¹ *System of Surgery*, p. 1256.

² *Lancet*, Dec. 12, 1874, p. 829.

removing the entire penis, was, I believe, introduced by Mr. Gould.¹ It ensures complete removal of the cancerous organ with its capsule.

Enlarged glands in the groin should always be extirpated as soon as it is probable that the enlargement is not merely inflammatory. A week or two's watching with appropriate treatment will settle this point. In any such operations the parts should be disturbed as little as possible, as erysipelas and sloughing are very likely to follow these operations where planes of fascia are much interfered with in those advanced in life. Where such operations cannot be performed antiseptically, owing to the existence of sinuses or the proximity of the genitals, the surface of the wound should be carefully washed with a solution of zinc chloride (gr. xx.—℥j.) For operations on the penis where frequent exposure of the part for the purpose of micturition is necessary, and it is thus needful to make use of some very simple arrangement which may be entrusted to the patient himself, boracic acid dressings, as introduced by Prof. Lister,² may be made use of. Prof. Lister, having described an amputation of the penis by antero-posterior flaps, gives the following details as to the dressings employed :—

The operation was performed under the spray, after the skin had been cleansed with a 1-20 carbolic lotion. The vessels having been tied with fine catgut, moist boracic³ lint was carefully adjusted so as to cover the end of the stump, but leave the urethral orifice exposed; and outside this permanent dressing a loose piece of the wet boracic lint⁴ was wrapped and covered with gutta-percha tissue, tied with the split end of a bandage which encircled the pelvis. This outer dressing was of course removed by the patient for micturition, and re-adjusted after washing with boracic solution; but the deep dressing was left untouched for two days, when it was taken off, entirely free from urinary odour; the drainage-tube having been taken out, fresh boracic acid lint was applied in the same way. The wound was again inspected two days later, and as there was not the slightest inflammatory blush, and as the stitches were evidently occasioning no tension, they were left undisturbed for three days longer, when they were found still lying in their places as they were after the operation a week before; and on their removal the cutaneous and mucous surfaces were found connected all round the urethral orifice in a line of perfect primary union, and the wound over the end of the stump was likewise entirely healed, except the part where the drainage-tube had lain. The same dressing was continued till this spot also had cicatrised, the blood-clot within the pouch of skin becoming organised without suppuration; and the patient left the hospital three weeks after the operation, having suffered literally no pain or inconvenience from first to last, and with a remarkably natural appearance of the part.

PHIMOSIS.

Only the congenital form will be here alluded to, the acquired or inflammatory form is usually venereal. A long prepuce is natural to a child, a fact that should be remembered when the question of circumcision arises. As long as the prepuce can be drawn back so as to allow of the glans being cleaned daily, like any other part of the child's body, there is no need of the operation. In many of the minor degrees of phimosis this result can be obtained by careful attempts at retraction of the prepuce, aided by injections of warm water. But where even partial adhesions have formed, where a pin-hole orifice only exists, or where the prepuce 'balloons' during micturition owing to the urine flowing into it more quickly than it can escape, the operation should always be performed. Otherwise the following undesirable results may follow as life goes on: (α) Balanitis and adhesions. (β) Paraphimosis, by the forcible retraction of a phimosed prepuce. (γ) From the straining to make water, urethral and vesical irritation may be set up, simulating the symptoms of stone. (δ) Cystitis. (ε) Prolapsus recti. (ζ) Paralysis of certain groups of muscles from the constant spinal irritation⁵ due to (η) Bad habits.

¹ *Lancet*, May 20, 1882, p. 821.

² *Ibid.* 1875, vol. i. p. 718.

³ Lint soaked in a saturated solution of boracic acid and wrung out.

⁴ Lint soaked in a saturated solution of boracic acid at nearly the boiling-point, then allowed to dry. Prof. Lister points out (*loc. supra cit.* p. 604) that before using this it is well to soak it again, 'not for the sake of adding fresh acid, but because the lint, when applied moist and allowed to dry on, is less liable to slip, and also for the sake of purifying the surface of the lint itself, which in the dry state has no power of acting upon septic dust adhering to it.'

⁵ Mr. Hilton, *Rest and Pain*, 3rd. ed. p. 276.

- (θ) Impediments to sexual intercourse. (ι) Intensified gonorrhœa, chancres,¹ &c.
 (κ) Epithelioma.

Circumcision.—This may be performed in very many different ways, but two points must be borne in mind in every case: (1) To remove enough of the mucous layer of the prepuce. If this be not done, some tension on the glans is left, and especially in adults, this leads to troublesome erections which interfere very much with the process of healing, and may, later on, leave some degree of phimosis. (2) Not to leave too much tissue about the frænum. Mr. Howse² has drawn attention to the fact that the cellular tissue at this spot is loose, and that the presence of the frænal artery makes probable the gathering of blood and inflammatory effusion at this spot. In children this is not a matter of importance, but later on in life it may lead to the formation of a persistent lump, interfering with the functions of the organ.

The following is a very simple method of operating. A long pair of dressing-forceps is lightly placed on the penis at a level with the corona; the glans having slipped back, the forceps are closed and all the prepuce in front of the glans is cut off with a sharp scalpel or scissors. The mucous layer is then slit up either with a director and scissors or with a sharp, curved bistoury, the mucous layer being held with forceps. In either case the incision should run right up to the corona. The mucous membrane is then detached in two flaps from the surface of the glans, to which it is often adherent, this detachment being effected by the finger and thumb or by a stout probe swept round. The square edges of the mucous membrane are now to be trimmed off with scissors and any superfluous part of it removed, enough being left to enable the cut edges of the mucous and cutaneous layers to be stitched together. For this purpose fine silk, or, in children, catgut may be used. In children three or four stitches are sufficient; in adults a continuous suture gives good results in healthy subjects. Interrupted stitches have, however, this advantage, that one or two can at any time be removed without interfering with the rest. In adults I prefer the boracic acid dressings which have already been described (p. 587). In children none are required, but a small piece of lint wrung out of carbolic oil, with a hole cut in it for the meatus, folded back and secured with thread, prevents friction and is easily changed.

Where the prepuce is tight, but not superfluous, it should be slit up along the dorsum as far as the corona, and the two layers, cutaneous and mucous, united with a couple of stitches on either side, the corners being rounded off.

After circumcision the patient should always rest absolutely for a week or ten days, alternate stitches being removed from day to day.

If the patient insists on getting about before the above period, he must run the risk of the parts remaining long cedematous and inflamed.

PRIAPISM.

This condition is a very rare one. The persistent erections may be incomplete or complete; in the latter case they are often extremely painful.³ Nearly always they are unaccompanied with sexual desire. Priapism is rare with disease of the brain, but has occasionally been met with in cases of cerebellar hæmorrhage.⁴ Its

¹ Mr. Hutchinson (*Med. Times and Gaz.* 1855, vol. ii. p. 542) points out 'that the circumcised Jew is very much less liable to contract syphilis than an uncircumcised person.' That this difference is not to be accounted for by their superior chastity, or by their unwillingness to seek medical aid for such diseases, is conclusively proved by the fact that (though in the proportion of nearly one-third to the other patients) they furnish very nearly half of the cases of gonorrhœa.

² *Guy's Hosp. Repts.* 1873, p. 239.

³ In a case of Mr. Birkett's (*Lancet*, 1867, vol. i. p. 207), in which persistent priapism was caused by extravasation of blood into the corpora cavernosa, the glans penis and corpus spongiosum not being turgid, the patient complained so bitterly of pain, that incisions were made to afford relief mechanically, a practice which Mr. Birkett would not again adopt.

⁴ Roubaud, *De l'Impuissance et de la Stérilité*, 1872, p. 280.

connection with injuries of the cord has been fully alluded to elsewhere (INJURIES OF THE BACK¹). It is not uncommon as a temporary condition in children with stone in the bladder, phimosis and ascarides. In one child who came under my notice with a nævoid condition of the prepuce and glans penis, priapism was constant. It sometimes, especially in those let down by excess or out of health, follows after coitus, particularly when this has been repeated frequently. In such cases it may be due either to excessive stimulation of the sensory peripheral nerves going to the sexual centre in the lumbar enlargement of the cord, or of the sexual centre itself. When it has followed an injury in coitus, it may be due to extravasation of blood into the spaces of the corpora cavernosa. Such cases are extremely tedious. Thus in the case alluded to above under the care of Mr. Birkett, the man was in Guy's Hospital for nearly five months.² Cantharides in large doses is known to produce erections without desire.

Treatment.—In some cases, as in those mentioned as occurring in children, the cause can be removed. In cases of excessive stimulation of the sexual centre either from the periphery below, or from the brain above, through emotional influences or mental excitement, bromide of potassium may be expected to give relief.³ When blood has been effused steps must be taken to promote its absorption. Incisions into the corpora cavernosa are not to be recommended, as they are liable to be followed by most tedious suppuration and in some cases by pyæmic symptoms.

CHRONIC INFLAMMATION OF THE CORPORA CAVERNOSA. THROMBOSIS OF THE CORPORA CAVERNOSA.

A chronic inflammation of the sheath and erectile tissue of the corpora cavernosa is occasionally observed in men about middle life. It comes on insidiously and often without cause. Sometimes a slight injury is assigned. A small patch of induration is felt as a hard and usually flattened mass near the surface of one or both corpora cavernosa. During erection the penis is noticed to be bent or curved. The mass itself gives but little pain, and feels like a thin plate of cartilage, often beneath the sheaths of the corpora cavernosa. The skin is quite unaffected.

In many cases this condition is due to chronic inflammation, which affects some patch of erectile tissue, filling up the loculi with exudation, and thus interfering with the even distension of the organ. This chronic inflammation may be set up by some slight injury⁴ or gout, or by both together.

In other cases a very similar state of things is produced by thrombosis or blocking of the venous spaces of the corpora cavernosa, this being especially likely to occur without strain or injury, that is spontaneously, in patients of gouty constitution. Mr. Prescott Hewett,⁵ in his address as President of the Clinical Society, has recorded two cases of this kind, of which the following is one. 'A gentleman, æt. 58, had shown in various ways a tendency to gout, and in this case, too, the trouble was accidentally discovered, there never having been any strain or injury of any kind. In the corpus cavernosum were four nodules, three on the left side and one on the right, varying in size from a pea to that of a French bean; they were perfectly circumscribed, hard to the touch, knot-like and painless when handled.

¹ A somewhat similar condition of satyriasis has been met with occasionally in locomotor ataxia. This is probable due to irritation in the lower dorsal or lumbar region of the sensory nerves, which run upwards from the sexual organs to the brain. In the *Med. Soc. Trans.* vol. i. pt. i. p. 174 will be found a case, recorded by Mr. Morris, in which ungovernable satyriasis appeared to be excited by pressure from a tumour in the perineum upon the pudic nerve.

² Other cases of priapism are recorded in the *Lond. Med. Repos.*, 1824, p. 286; *Lancet*, July 1845; *Lancet*, Jan. 18, 1873; *Lancet*, June 7, 1823; *New Orleans Journ. of Med.* Jan. 1869.

³ In a case reported by Dr. Hargis fifteen grains of the salt given every two hours gave speedy relief.

⁴ Van Buren, *Surg. Dis. of the Gen. Ur. Organs*, pp. 25, 26.

⁵ *Clin. Soc. Trans.* vol. vi. p. xl.

There were no enlarged glands in the groins, the patient had never had syphilis, and he was of good health and of his usual weight. I first examined the case two years back, and all that has occurred from that time to this is a marked diminution in the size of the nodules, two of them having disappeared, leaving merely a trace of thickening, and the largest being now not bigger than a pea. . . . During these two years the case was left undisturbed by treatment; no medicine of any kind has been taken; nothing was applied locally, the disease was left to its natural course.'

Treatment.—It is not advisable to attempt much by way of treatment. In the early stages of the inflammatory condition blisters or the use of tincture of iodine externally, combined with the administration of small doses of blue-pill or hyd. cum cret. internally, may effect a cure, but later on they seem to increase pain without promoting absorption.

Both Sir J. Paget¹ and Mr. Prescott Hewett² speak of the advisability of not making use of active treatment in cases of gouty phlebitis.

GEORGE MURRAY HUMPHRY, 1871.

WALTER H. A. JACOBSON, 1882.

¹ *Clin. Lect. and Essays*, p. 297.

² *Loc. supra cit.* p. xli.

DISEASES OF THE THYROID GLAND.

THE thyroid gland, one of the vascular bodies without ducts, consists of two lateral lobes, connected by an isthmus, which crosses in front of the three upper rings of the trachea. Hyrtl affirms that he has met with instances of complete congenital absence of the isthmus; and in aged subjects it is sometimes so far absorbed as to be scarcely distinguishable, the two halves of the gland appearing to be united only by areolar tissue. The entire gland may be congenitally absent, this deficiency having been observed in several cases of sporadic cretinism.¹ The proportion of the gland to the entire body diminishes with age. In new-born infants it is 1 : 300; at the end of the first month it is 1 : 1,200; in adults it falls to 1 : 1,800.² It is supplied by four, and sometimes by five, large arteries, branches of the carotid and subclavian trunks; the fifth artery, when it exists, lying in the median line of the trachea. The organ lies, moreover, in close contiguity to the great vessels and nerves of the neck.

The most common disease of the thyroid gland is the chronic enlargement commonly known as 'bronchocele.'

Acute inflammation of the thyroid body in its natural condition is but rarely seen, and is usually secondary; inflammation and suppuration of the previously enlarged gland, although not common, is occasionally met with.

The endemic form of bronchocele, or goitre, occurs chiefly in association with cretinism, and seems to have some hitherto unexplained connection with geographical conditions. It prevails in Derbyshire, Nottingham, and the chalky parts of England; in the valleys of the Alps, Apennines, and Pyrenees. Postiglione remarks that in Savoy, Switzerland, the Tyrol, and Carinthia, there are villages in which all the inhabitants, without exception, have these swellings.³ The cause commonly assigned, namely, the use of melted snow, or of water impregnated with calcareous or earthy particles, is unsatisfactory. Capt. Alexander Gerard, in his account of Korrawur, in the Himalayas, says, 'Although the Korrawurees can get nothing but snow for some months in the year, they are not so subject to goitre as the people who live in the damp grounds in the forest at the foot of the hills, where there can never be any snow-water. The water which flows from the hills of lias, forming the Asiatic side of the Dardanelles, is impregnated with lime; but yet during a residence of many months I did not notice the prevalence of goitre.' This idea has been successfully refuted by Alibert; and Foderé has explained how the disease cannot be referred to the use of any particular kind of food. Dr. Guggenbühl, the founder of the Cretin Hospital, remarks that both cretinism and goitre, which may exist either conjointly or separately, prevail in deep valleys, where the air stagnates, and the population, scanty in numbers, becomes deteriorated by frequent intermarriage. Cases of goitre and idiocy removed to an elevated position, and properly nurtured, are first made to thrive bodily, and then are susceptible of mental improvement; and he particularly relates the case of a cretin child, who after having passed a life of complete insensibility to external objects, gave suddenly the first indication of aroused consciousness, after proper treatment, by exclaiming, 'Die Sonne!' (the sun), as the light of day fell on the spot where he was seated. Humboldt says that persons affected with bronchocele are met with in the lower course of the Magdalena River, from Honda to the conflux of the Cauca, in the

¹ Curling, *Med.-Chir. Trans.* vol. xxxiii. p. 303. Hilton Fagge, *ib.* vol. liv. p. 155. Fletcher Beach, *Path. Trans.* vol. xxv. p. 265; vol. xxvii. p. 316.

² Hyrtl, *Topog. Anat.* B. i. S. 357.

³ *Memoria sulla Natura del Gozzo*, p. 22.

upper part of its course, between Neiva and Honda, and on the high country of Bogota, six thousand feet above the bed of the river. The first of these three regions is a thick forest, while the second and third present a soil destitute of vegetation; the first and third are extremely damp, the second is peculiarly dry; in the second and third the winds are impetuous, in the first the air is stagnant. To these striking differences we will add those relative to temperature. In the first and second regions the thermometer keeps up all the year between 71° and 73° F.; in the third it ranges between 37° and 62° F. The waters drunk by the inhabitants of Maraquita, Honda, and Santa Fé de Bogota, where bronchoceles occur, are not those of snow, but issue from rocks of granite, freestone, and lime. The temperature of the waters of Santa Fé and Mompo, drunk by those who have this disease, varies from nine to ten degrees. Bronchoceles are the most hideous at Maraquita, where the springs, which flow over granite, are, according to Humboldt's experiments, chemically more pure than those of Honda or Bogota, and where the climate is much less sultry than upon the banks of the Magdalena River.¹

Endemic goitre admits of but little benefit from treatment, although some improvement may be occasionally obtained by the removal of the patient to healthier surroundings, by a careful attention to hygiene, and by the internal administration of iodine.

The *sporadic form of bronchocele* may be met with in any part of the country: it is often seen in persons whose health is otherwise good, and whose environment is perfectly satisfactory.

It occurs most frequently in unmarried women, and is often associated with disturbed menstruation. Men are, however, by no means exempt from the disease.

In pregnant women the thyroid gland often exhibits an enlargement, which is usually temporary, but sometimes becomes permanent.

The enlargement of the thyroid gland in bronchocele is of several kinds. It may be due to growth of the solid constituents of the gland, or to the development of one or many cysts, or to a combination of both these processes.

An examination of the solid bronchoceles reveals either (*a*) a simple hypertrophy of all the elements of the gland, or (*b*) an overgrowth of its connective tissue, or (*c*) an increase in the vascularity of the organ.

(*a*) '*Simple bronchocele*' is the name usually given to those cases in which the enlargement of the gland depends upon a chronic hypertrophy of all its tissues. This hypertrophy may be either general or local. Sometimes the shape of the gland remains unaltered, it is simply larger than natural; but more often, though the whole gland is increased in size, the growth is irregular, giving rise to a diffused uneven swelling on each side of the neck. It is not uncommon, however, for only one lobe to be affected; and the growth may even be of detached nodules, quite separate from the main portion of the gland.

This form of bronchocele is soft and elastic, and of uniform texture throughout. It does not as a rule give rise to any severe symptoms, but is inconvenient chiefly from its size and the deformity which it produces. It sometimes disappears spontaneously; it may remain long unchanged, or it may undergo cystic or fibrous degeneration.

(*b*) *Fibrous bronchocele* is that form of enlargement of the thyroid gland in which the hypertrophy is chiefly of the connective tissue.

The connective-tissue growth is not usually distributed equally throughout the gland, but is more abundant in some parts than in others, so that firm nodules can be detected in the midst of the softer tissue of the gland.

Fibrous bronchocele varies much in its size and rate of increase, the same tumour often displaying various degrees of activity at different periods of its growth. It is

¹ Humboldt, in *Journ. de Physiologie*, par F. Majendie, tom. iv. p. 116.

For an elaborate account of the various theories concerning the causation of endemic goitre, with references to the literature of the subject, the reader may be referred to Dr. J. Saint-Lager's work, *Études sur les Causes du Crétinisme et du Goître endémique*, Paris, 1867.

much harder than the simple hypertrophic variety, from which also it is distinguished by its inequality of texture, by its nodular form, and by its definite outline. Parts of such tumours are prone to undergo contraction into fibrous masses of extreme density, which feel to the touch of cartilaginous hardness, and may subsequently undergo calcareous degeneration. This variety of bronchocele is a much more serious disease than the simple form, inasmuch as it is apt to produce dangerous pressure upon the neighbouring parts. This is especially the case when it extends behind the sternum, in which situation compression of the trachea occurs early in the progress of the growth. The windpipe may also be displaced or twisted by enlargement of one part of the gland, or seriously narrowed by compression between the two lobes.

The growth may also become troublesome by causing pressure upon the œsophagus, or upon the adjacent vessels or nerves.

(c) *Pulsating bronchocele* is due to an increase in the vascular tissue of the gland, and to some unexplained change in the condition of the circulation which leads to dilatation and fulness of its vessels. This condition is usually only one among other local manifestations of the disease known as exophthalmic goitre, or Graves's disease; but occasionally a bronchocele is observed to become preternaturally vascular, and even to pulsate, without the occurrence of the other symptoms of Graves's disease, in which case the pulsation is generally only a temporary phenomenon.

Cystic bronchocele.—Cysts are frequently met with in combination with the solid enlargements of the thyroid gland above described. Sometimes the disease is chiefly cystic from the first; in which case there may be either one thin-walled cyst which often attains a large size and which grows from the otherwise unaltered gland, or numerous smaller cysts, the walls of which are formed by the hypertrophied gland-tissue.

In other cases cysts are developed in bronchoceles which have for a time consisted entirely of solid growth.

In whatever part of the gland cysts originate, the tendency is for them to grow towards the surface, and they often attain a great size. They contain either a gelatinous material, or fluid which is of a serous character, or which contains altered blood and cholesterine. They may also contain solid intra-cystic growths of thyroid glandular tissue. The walls of such cysts may become thickened by fibrinous deposit or hardened by calcification.

It follows, therefore, that cystic bronchoceles present many varieties, both in form, size, texture, and the symptoms to which they give rise. The large single cysts are easily recognisable, and so are the smaller ones which are developed upon the front of the gland; but it is often difficult to detect cysts situated in the deeper parts of the gland, although a rapid increase in the size of a bronchocele and a serious amount of pressure upon the neighbouring parts may be caused by their growth or development.

The *diagnosis* of an enlarged thyroid gland from other tumours of the neck will usually be much facilitated by observing its connection with the trachea, the movements of which it follows during deglutition; in very large bronchoceles, however, the trachea may be so far concealed as to make this distinction unavailable. It must of course be remembered that pulsation may be easily conveyed from the carotid artery to the enlarged lateral lobe of the thyroid gland, and that in such cases the vessels often beat with unusual force; and moreover that inherent pulsation is not an uncommon feature of bronchoceles: but such tumours are distinguished from aneurisms by the absence of expansile movement, by the fact that they are not diminished by pressure on the vessel, that they are mostly separable from the great vessels by careful manipulation, and that they are fixed most firmly to the deeper structures towards the middle line.

The *prognosis* of cases of bronchocele must generally be doubtful, for instances are not uncommon in which the thyroid enlargement, after remaining stationary for a long time, has suddenly undergone a rapid and dangerous increase.

Simple hypertrophy of the thyroid gland sometimes disappears spontaneously, and is not usually dangerous to life; but Sir Risdon Bennett records a case in which

the hypertrophy progressed so rapidly as to cause death from suffocation within three months of the appearance of the first symptoms. The patient was a young man, and the growth chiefly substernal.¹

So also the enlargement of the thyroid gland which occurs in pregnancy, though not as a rule of serious importance, has occasionally been known to prove fatal.²

Fibrous bronchocele should always be regarded as a serious disease, especially if it extend downwards behind the sternum, for it is this variety which is especially prone to produce dangerous compression of the trachea, of which many fatal examples are on record.

Treatment.—In the treatment of all cases of bronchocele attention should be paid to the general condition of the health. In women, the subjects of this disease, some disturbance of the menstrual function is often observed, and should be corrected; in many cases anæmia is a marked symptom, and in these iron is of much benefit. The environment of the patient should also be carefully looked to, sunlight and fresh air being important aids to recovery, as is also removal from a goitrous district, and from low and damp situations. Care should also be taken to ensure the purity of the drinking water.

The internal administration of iodine is of great value in the simple form of bronchocele, and is often followed by rapid and permanent improvement. In a case under my own notice a large bronchocele disappeared almost entirely in a few days, after the occurrence of iodism produced by large and frequently repeated doses of iodide of potassium. In other instances I have observed that, though a rapid improvement takes place at first on the administration of iodine, yet after a short time the diminution of the tumour ceases, and the medicine seems of no further benefit. When this occurs, or if, as sometimes happens, no benefit is derived from iodine, counter irritation over the surface of the tumour should be resorted to. For this purpose ordinary blistering fluid should be painted over the swelling with sufficient frequency to keep up a series of blisters.

Fibrous bronchoceles are best treated by setons, introduced through the substance of the enlarged gland, and left in long enough to excite suppuration and shrinking of the growth. This has long been known as a valuable method,³ and is not usually attended with much inconvenience or constitutional disturbance.

The seton is not adapted to cysts of the thyroid gland, for its use in such cases has been followed by dangerous and even fatal inflammation.⁴

The best treatment for cystic bronchocele is that introduced by Dr. Morell Mackenzie,⁵ which consists of tapping the cyst with a trocar and cannula, emptying it, and then injecting through the trocar a solution of perchloride of iron (two drachms to an ounce of water). The cannula is plugged and left in the cyst. In this way the tendency to hæmorrhage which these cysts often display is prevented, and the cavity is converted into a chronic abscess. The injection is repeated if necessary at intervals of two or three days until suppuration is established; the cannula is then withdrawn, and the drainage of the cavity provided for until it shrinks and heals.

Simple tapping or incision has sometimes been successful, but there is always a danger of hæmorrhage attending these measures, which is obviated by the use of the iron injection.

In bronchoceles in which cysts are combined with fibrous growth ('fibro-cystic bronchoceles') the cysts should first be obliterated by puncture and injection of solution of iron; and if after this there remain any considerable solid growth, it should be treated by setons. Occasionally the dyspnœa caused by the pressure upon the trachea of an enlarged thyroid gland has been relieved by subcutaneous tenotomy of the sterno-mastoid muscle.

¹ *Lumleian Lectures on Intra-thoracic Growths*, p. 167, 1872.

² Guillot, *Archiv. gén. de Méd.* t. xvi. 1860.

³ See Dr. Somerville's communication to the Medico-Chirurgical Society of an account of this method as used by Dr. Quadri, of Naples, *Med.-Chir. Trans.* vol. x. p. 16.

⁴ See a specimen in the Museum of St. George's Hospital, Ser. x. No. 27.

⁵ *Lancet*, 1872, vol. i. p. 642.

The injection of iodine into, and the subcutaneous laceration of bronchoceles are methods which have not been attended with encouraging results.¹

The removal of a bronchocele is usually a grave operation, and should not be undertaken unless there are urgent reasons until simpler measures have failed.

These tumours are freely supplied with large thin-walled blood-vessels, which are easily lacerated and with difficulty secured. The danger of hæmorrhage during the operation is therefore considerable; but besides this there are the subsequent risks of deep-seated suppuration in the neck.

Notwithstanding these considerations, there can be no doubt that extirpation of a bronchocele is sometimes necessary: for instance, if the tumour, in spite of treatment, is producing increasing dyspnoea, or is growing downwards towards the sternum; or if, as in a case related by Mr. Holmes,² the patient is becoming exhausted by profuse suppuration. Accounts of cases in which large bronchoceles have been extirpated have been published by Dr. Warren Greene,³ Prof. Billroth,⁴ Mr. T. Holmes,⁵ Dr. P. H. Watson,⁶ and others, which, while proving that the operation is both justifiable and practicable, show also that it is one of much difficulty and severity.

Two points require especial attention in performing this operation: the first is that ligatures should be passed around the vascular connections of the tumour, so as to include the thyroid vessels, before any attempt is made to remove the tumour; the second is that great care should be taken not to disturb the thin fascia which forms the immediate investment of the gland, until the chief vessels have been secured.

Unless these precautions are taken, the separation of the fascia propria of the gland is always followed by severe hæmorrhage, owing to the laceration of the large thin-walled vessels which ramify beneath it; and a similar danger is incurred by the tearing of any part of the hypertrophied gland. The surface of the tumour should therefore be exposed by a free incision, care being taken not to wound the investing fascia, and strong ligatures are then passed by an aneurism needle beneath the base of the tumour, which is to be tied in four portions. After which the fascia is to be opened, and the tumour separated from its surroundings by the finger and curved scissors.

Dr. Patrick Henry Watson published, in 1873, an account of a method of operating by which he secured each set of thyroid vessels at the margin of the gland so as to prevent subsequent bleeding. His description is as follows:—‘After dividing the skin and cellular tissue, and opening the fascia over the interval between the sterno-hyoid and thyroid muscles, carefully avoiding the fascial sheath of the thyroid gland, I carried my forefinger and thumb over the margin of the tumour at its upper and right-hand corner, and feeling that I had the vascular connexion of the tumour with the right superior thyroid artery in my grasp, I introduced an aneurism needle through the fascial sheath in the middle line, bringing it out again at the right side of the level of the equator of the tumour. A ligature was passed through the eye of the needle, and when the needle was withdrawn, the ligature was left in its track. The ligature was confided to an assistant and held aside. The needle was again passed in the situation of its former emergence, guided by the finger, and then passed beneath the right inferior margin of the gland so as to include all the right inferior thyroidal connexions. The ligature was similarly withdrawn along the track of the needle. The same process was repeated upon the left side, a ligature being carried beneath the left superior and inferior thyroidal connexions, together with their delicate investing fascia. These four ligatures were then separately tied so as to secure the vessels included within their cellular sheath as far from the tumour as was possible: the further separation of the tumour was effected by curved scissors.’

¹ See Billroth, *Clinical Surgery*, Sydenham Soc. Trans. p. 160.

² *American Journal of Med. Sciences*, Jan. 1873, p. 17.

³ *Ibid.* Jan. 1871, p. 80.

⁵ See note 2. See also a case of Mr. Wood's, *Path. Trans.* vol. xxix. p. 206.

⁶ *Edinburgh Medical Journal*, Sept. 1873.

⁴ *Op. cit.* p. 162.

⁷ *Ibid.* Sept. 1873.

He adds the following directions, which are worthy of careful attention :—

‘(1) The external incision should be very free, extending from the larynx to the notch of the sternum if the tumour is large and spreads widely in a lateral direction. (2) The vessels, arterial and venous, in the superficial incision should be secured as they are divided, to avoid any obscuration of the parts through oozing going on. (3) The fascia should be as freely opened as the skin. (4) The investing delicate fascial sheath of the thyroid should be left undivided until the mediate ligature of the vessels included in their fine cellular sheath has been effected. This sheathing fascia or cellular capsule of the thyroid gland is only a prolongation of the sheath of these thyroidal vessels. If the capsule is opened, then, in pushing aside the soft parts to disclose the outline of the tumour, this delicate sheath is apt to glide off the surface of the thyroid gland; and should this occur, the gland may readily be detached from the vessels even with comparatively gentle handling, and thus copious hæmorrhage, difficult of restraint, may be occasioned. (5) After the mediate ligature of the thyroidal vessels in their sheathing cellular envelope, the cellular capsule of the thyroid gland should now be opened by scratching through it in the middle line, and the attachments which still retain the goitre in its position carefully divided by means of curved and blunt-pointed scissors. There should be no tearing away of the gland, no pushing parts aside with any roughness of manipulation. (6) Should bleeding occur, it must be recollected that it must take place within the cellular sheath of the vessel, and its prolongation upon the gland in the fashion of an investing capsule; and that if the vessels are to be tied, they should be secured along with the cellular sheath. Without this sheath these enlarged trunks will be found so fragile as to risk being cut by the ligature; while any attempt to reach the bleeding mouths will usually be baulked by the infiltration by clot of this cellular envelope.’

‘The chromicised catgut introduced by Mr. Lister¹ may be used with advantage in this operation, instead of the ordinary silk ligature, as the ends may be cut short and the wound closed over them.

Care should, of course, be taken to ensure proper drainage of the wound, and absorbent antiseptic dressings, such as thymol wool, may be conveniently applied.

The outlying growths of thyroid gland tissue which are met with in the neighbourhood of the gland proper can usually be removed with less difficulty. I removed such a tumour a short time since from a young man, which, though its deep attachment was to the side of the lower part of the trachea, had no vessel of any magnitude passing into it.

Cancer of the thyroid gland is rare, and occurs mostly in glands which have been previously affected with bronchocele. Dr. Payne has related such a case, and alludes to Virchow’s collection of instances of the same sequence of these two diseases; a sequence which, he remarks, ‘is the more striking if the rarity of cancer in the thyroid under any circumstances be taken into account. It appears to illustrate the general law that cancer is likely to arise by preference in some part of the body previously damaged by injury or disease.’²

In vol. xxvii. of the ‘Transactions of the Medico-Chirurgical Society’ Mr. Cæsar Hawkins relates a remarkable case of malignant disease of the thyroid gland associated with a similar growth of the skull,³ and he says ‘the texture of the tumour of the bone was nearly the same as that of the thyroid gland, soft, elastic, dark-coloured, and with a mixture of cells of serous or bloody fluid.’

Mr. Henry Morris has also published a somewhat similar case, in which a bronchocele was associated with pulsating tumours of the parietal bone, clavicle, and thigh-bones. In this case, also, the cranial tumour (which was the only one examined post mortem) was of spongy texture, and under the microscope exhibited a structure

¹ See *Clin. Soc. Trans.* vol. xiv. Address by President, p. lvi. Mr. Lister also recommends (p. xlv. of his Address) that in removing the thyroid in this way the tumour should be divided in the middle line, so as the more easily to admit of dissecting it from off the trachea.

² *Path. Trans.* vol. xxii. p. 285.

³ The specimen is in the Museum of St. George’s Hospital.

closely resembling that of a bronchocele.¹ The Morbid-Growths Committee of the Pathological Society, in reporting on this specimen, questions 'whether this and the other tumours were not secondary to a primary affection of the thyroid body;' and reference is made to two other precisely similar cases.

I have recently had under my care at St. George's Hospital a case in which, coincidently with the enlargement of a long quiescent bronchocele, pulsating tumours were developed in connection with the ilium and scapula; besides which there was a non-pulsating tumour of the cranium. Post-mortem examination revealed growths, closely resembling the microscopic appearances of the bronchocele, not only in the bones above mentioned, but also in the bones of the spine, the kidney, lung, liver, and spleen.²

It would appear, therefore, from these cases that when malignant growth takes place in a bronchocele it is apt to be associated with, or followed by, similar growths in the bones.

Drs. Wilks and Moxon mention an instance of a hydatid cyst occurring in the thyroid gland.³

Exophthalmic Goître (Graves's Disease).—This is a disease of which the goître is only one symptom among others which are chiefly referable to the organs of circulation. It will only be necessary, therefore, to make brief reference to this affection in connection with diseases of the thyroid gland.

Its most marked features are palpitation of the heart, painful pulsation of the carotid arteries, protrusion of the eyes, and enlargement and pulsation of the thyroid gland; the symptoms generally being observed in the sequence in which they are here mentioned. Murmurs are often heard at the base of the heart and along the vessels of the neck, and the circulation is easily still further disturbed by any kind of excitement. After a time the heart may become hypertrophied, but in many cases it remains structurally unaltered. The thyroid gland varies in size, is soft, and pulsates with a musical bruit. The changes found on post-mortem examination of the gland are chiefly hypertrophy and vascular dilatation; but its structure varies, and 'there is no known post-mortem condition of the thyroid gland proper to this disease' (Wilks and Moxon).

The eyes are sometimes so much protruded that the corneæ slough, but the amount of exophthalmos varies, and sometimes it subsides entirely after death.

The disease is seen most commonly in young women, and is often associated with anæmia and amenorrhœa; but men are not exempt from it. Its progress is uncertain; and although it gives rise to much distress, it is very rarely fatal. Often the symptoms slowly increase, and then after a time become stationary or subside; the prognosis is, therefore, as a rule not unfavourable, and will depend chiefly upon whether or not there is any organic heart disease.

The cause of this curious affection is not understood, although it seems probably to depend upon some disturbance of the sympathetic nervous system. Clearly, however, it is something quite different from ordinary bronchocele, and instances are not wanting in which all the other symptoms have been observed without the thyroid enlargement.

The treatment should be directed to the removal of any obvious cause of excitement or vascular disturbance, and to the correction of anæmia, menstrual irregularities, and nervous irritability.

Quiet, mental and physical; careful diet; iron, digitalis, belladonna—these are the remedies which are ordinarily most useful; and they may be combined with the local application of cold to the enlarged thyroid gland.

HOLMES COOTE, 1871.

J. WARRINGTON HAWARD, 1882.

¹ *Path. Trans.* vol. xxi. p. 259.

² For the details of this case see *Trans. of the Pathological Society* for 1882, where also I have referred to other similar cases. See also a paper by Dr. E. Neumann in *Langenbeck's Archiv für klinische Chirurgie*, vol. xxiii. 1879.

³ *Path. Anat.*, 2nd ed. p. 290.

ANÆSTHETICS.

PART I. WRITTEN 1861.

TO prevent or diminish pain in surgical operations is an object so desirable, that many in various ages in the history of Medicine have sought to attain it, either by means of narcotic drugs designed to act on the body generally, or by compressing or otherwise locally affecting the nerves of the part concerned.¹

The first really valuable suggestion, however, was made in the year 1800 by Sir Humphry Davy, who, having himself experienced relief from pain when breathing nitrous oxide gas, threw out the hint that it might probably be employed with advantage to produce a similar effect in surgical practice.²

The same idea occurred, after the lapse of nearly half a century, to Dr. Horace Wells, a dentist in Hartford, Connecticut, who, in 1844, underwent the extraction of a tooth without pain after inhaling the gas, and gave it with satisfactory results to several of his patients; but he soon after found the practice so uncertain that he abandoned it entirely.³

About the same period Dr. W. T. G. Morton, of Boston, in America, who had previously been a partner with Wells, but did not, as he informs us, receive any suggestion from him, became possessed with the desire of discovering an efficient anæsthetic, and commenced a series of experiments upon himself and the lower animals, which at last resulted in his extracting a tooth painlessly from a patient to whom he had administered the vapour of sulphuric ether by inhalation. This was on September 30, 1846.⁴ Soon afterwards he publicly exhibited his method at the Massachusetts General Hospital; and thenceforward anæsthesia in surgery was an established blessing to mankind.

Sulphuric ether is still extensively used as an anæsthetic in America; but in Europe chloroform is generally preferred to it. Disguised under the name 'chloric ether,' in which it exists diluted with spirit of wine, this agent was the subject of Dr. Morton's first experiment upon himself;⁵ and it was used in the same form at St. Bartholomew's Hospital, in preference to sulphuric ether, by Mr. Lawrence in the summer of 1847.⁶ In the autumn of that year Dr. (afterwards Sir James Y.) Simpson, who was engaged in a series of experiments with various narcotic vapours, employed for the first time the active principle of chloric ether, at the suggestion of Mr. Waldie, of the Apothecaries' Hall of Liverpool;⁷ and finding that the pure chloroform was more potent than sulphuric ether, yet caused less bronchial irritation, while its odour was more agreeable, and its inferior volatility rendered its exhibition more easy,⁸ he zealously recommended it to the profession, and it has since been generally employed throughout Europe.

¹ For much curious information regarding the history of this subject the reader is referred to the work of the late Dr. Snow on *Anæsthetics*.

² *Chemical Researches*, p. 556.

³ *Statements of William T. G. Morton, M.D., on his Claim to the Discovery of the Anæsthetic Properties of Ether, &c.* Washington, 1853, pp. 42, &c.

⁴ Dr. Morton's *Statements*, &c. pp. 45, &c.

⁵ *Op. cit.* pp. 45, 46.

⁶ Snow on *Anæsthetics*, p. 20. That chloric ether was employed at St. Bartholomew's Hospital has been further confirmed by information kindly communicated to me by Mr. (now Sir James) Paget.

⁷ Snow on *Anæsthetics*, pp. 21, 22; also Dr. Simpson's original pamphlet, *Account of a New Anæsthetic Agent, &c.* p. 6.

⁸ For operations performed by artificial light, chloroform has another advantage over ether, in the fact that its vapour is not inflammable.

The effects produced by chloroform are such as to fit it remarkably for the purposes of the surgeon. Like most narcotics, it tends to cause, after temporary excitement, suspension of the functions of the nervous centres, but affects them not simultaneously, but in a certain order; and the brain is the first to show loss of power in failure of sensation and voluntary motion. If this were all, anæsthesia would be a questionable boon, as the work of the surgeon would be interrupted and often marred by involuntary struggles on the part of the patient. But very soon the spinal cord also is subdued, and the reflex functions of the cerebro-spinal axis are abolished so far as concerns the voluntary muscles, which consequently lie perfectly relaxed and passive, better suited for operative purposes than the most resolute will could render them. To this, however, there is one remarkable exception, viz. that the parts concerned in the respiratory movements remain active; and the same is the case with the sympathetic ganglia of the heart. In other words, when the administration of chloroform is carried to a certain point, the nervous system is deprived of such powers as would cause pain to the patient or inconvenience to the surgeon, but retains intact the faculties essential to life.

There are, however, yet other advantages derived from the inactivity of the cerebro-spinal centre. It seems now clearly established that the cessation of the contractions of the heart in the shock of injury depends upon an action of the brain and cord upon the cardiac ganglia through the medium of the vagus and sympathetic nerves; and chloroform, rendering this action impossible, protects the heart from the indirect effect of external violence. In this way it has greatly diminished the risk of death upon the operating table, and also has overthrown the old rule of deferring amputation in cases of injury till the patient has recovered from the state of collapse; thus shortening the period of mischief to the system from the presence of the mangled limb, and in extreme cases sometimes saving life where it would be hopeless to wait for returning consciousness. Indeed, an amputation performed under chloroform has often the effect of improving instead of lowering the pulse.

The most striking instance of this that has fallen under my notice occurred in a labourer, whose right arm and thigh had been destroyed by a railway accident, just enough sound tissue being left to admit of amputation through the hip and shoulder joints, which was accordingly performed as a forlorn hope by the surgeon in charge of the case. The vital powers being in a state of extreme depression, it is probable that without chloroform this severe measure would have killed him outright, but by help of the anæsthetic it was followed by marked improvement of the pulse, which continued for some hours, so as to lead us to entertain hopes of his recovery.

Faintness during the operation, a species of shock, is also got rid of by chloroform; and this, besides its obvious convenience, has the advantage of lessening the chance of secondary hæmorrhage; for the vessels which require ligature declare themselves as such by bleeding, instead of deceptively eluding observation in consequence of the feebleness of the heart and the general arterial contraction which coexist in the state of syncope.

The welfare of the patient is besides greatly promoted by the mental tranquillity arising from the prospect of immunity from suffering, which also induces persons to submit much more readily to the necessary operations, and often to undergo without hesitation treatment which was formerly impracticable because intolerable.

Such being the great benefits conferred by this agent, it is melancholy to reflect that in many parts of Europe, and even of the United Kingdom, it is either withheld altogether or given so scantily as to be nearly useless. This arises from fear, inspired by several fatal cases that have occurred. But when I state that Mr. Syme has given chloroform about five thousand times without ever meeting with a death, and that Sir J. Simpson's experience, also very extensive, has, so far as I am aware, been equally satisfactory, it is clear that it may be used so as to be practically free from any risk whatever.

How then are the fatal cases to be accounted for? Heart disease has been supposed to be a common cause of them; and it is a prevalent opinion that it is highly dangerous to administer chloroform to persons affected with cardiac disorder.

It happens that the only death I ever witnessed under chloroform occurred in a person whose heart proved, on examination, to be extensively affected with fatty degeneration, such as would be regarded as sufficient explanation of sudden death under any circumstances. The particulars of this case, however, presented peculiar features, which lead me to take a different view of the part played by the chloroform from what might at first be assumed. The patient was a man above the middle period of life, affected with cancer of the penis, for which amputation of the organ was to be performed. The gentleman in charge of the chloroform, considering the momentary nature of the operation, purposely abstained from giving it as fully as usual, and had removed the cloth containing it from the face before the operation was commenced. The surgeon now placed his finger on the patient's wrist, and having ascertained that the pulse was good, at once effected the amputation almost instantaneously. I observed that the passage of the knife through the member was accompanied by a start of the patient's body; the bandage used to control the bleeding was then removed, but no blood flowed from the arteries: he was found to have no pulse at the wrist: in short, he was dead. From these facts we can hardly doubt that death was a consequence of the shock of the operation acting on a diseased heart; and the only question is whether the circumstance that he had taken chloroform promoted that result. From the foregoing considerations such a thing seems altogether improbable, as we have seen that chloroform protects the heart from the effect of shock. The fact that the patient started proved that reflex action was not abolished in the voluntary muscles, and confirmed the statement of the administrator that the chloroform was imperfectly given. My own impression is, that if it had been pushed to the usual degree, the fatal occurrence would have been averted.

I have given this case in detail because I believe it may be regarded as typical of a considerable class in which death has taken place suddenly at the commencement of an operation with imperfect administration of chloroform, which stands to the fatal event in the relation of an accidental concomitant, or rather a preventive insufficiently used.¹

A death essentially similar, though more obviously unconnected with chloroform, took place on the occasion when it was intended to have administered it for the first time in the Edinburgh Infirmary; but Dr. Simpson being prevented from attending, the operation was commenced without the anæsthetic, and the patient died suddenly immediately after the first incision. It has been often remarked that if the original intention had been carried out, chloroform would never have been heard of again in Edinburgh; but it is very likely that the man might then have lived to testify to its benefits.

There is another class of fatal cases in which the use of chloroform seems to have been simply a coincidence, the real cause of death being mental emotion, acting usually upon a disordered heart.

Dr. Snow mentions a distinct example of this, where a mere profession of administering chloroform was made, and the patient died of fright;² and I am able to give, from Edinburgh experience, an instance in which chloroform was still more remotely concerned. The late Dr. Richard Mackenzie, being called to see a gentleman who had fractured his radius, had some thought of employing chloroform in examining the arm, but, changing his mind, made the necessary manipulations without it. He then proceeded to leave the house; but had not got down the steps leading from the door when he was called back with the announcement that his patient had suddenly expired.

Had chloroform been held near the face a few seconds before this occurrence, it would certainly have been blamed, though with manifest unfairness; and a similar injustice seems to have been committed with regard to several cases in which fatal syncope has taken place early in the administration of the anæsthetic, when the brief period of inhalation concurred with the symptoms in showing that the patient was little, if at all, under its influence. A fear of the chloroform itself seems to have been the exciting cause in some of these cases; and one reason why no such

¹ An observation made several years ago by Mr. Bickersteth, of Liverpool, has an interesting bearing upon this class of cases. He noticed on three occasions in amputation of the thigh that the pulse stopped suddenly at the moment the knife entered the limb, but recovered itself in a few seconds. The patients were under the influence of chloroform; but as Mr. Bickersteth never observed the same thing again, though he watched the pulse carefully at the same period in a great number of capital operations under chloroform, it seems probable that the anæsthetic was not administered to its full degree in those instances. (See *Monthly Journal of Medical Science*, September 1853.)

² Snow on *Anæsthetics*, p. 201.

instance has occurred in the Edinburgh Infirmary is probably the unlimited confidence reposed in this agent by the inmates of that institution.

It might, perhaps, have been expected *à priori* that chloroform, in the early or exciting stage of its operation, would act upon a diseased heart like mental emotion, and cause irregularity or cessation of its contractions. This, however, does not seem to be the case; and, judging from my own experience, I should say that it tends rather to remove intermission or irregularity of the pulse. On the whole I believe that chloroform, by preventing shock and mental effort during the operation as well as anxiety before it, is in reality a great source of safety in heart disease; and that if a person with known cardiac affection decides to place himself in the hands of the surgeon, so far from being unsuited for the anæsthetic, he is before all others the man who stands most in need of its protecting influence.

Nevertheless, even when the heart is perfectly healthy, it is quite possible to administer chloroform so as to produce a directly sedative and deadly influence upon the cardiac ganglia. This truth was deeply impressed upon me eight years ago by the following occurrence.

An eminent London physician, desirous of making some experiments upon the heart, selected a young donkey for the purpose, and requested me to maintain artificial respiration, which was done by means of a large pair of bellows connected with a tube tied into the trachea, the animal having been previously put under the influence of chloroform. The chest having been opened, the investigation was continued for a while, when the creature began to exhibit signs of returning consciousness. To avert this I removed the bellows, and poured into them a considerable quantity of chloroform, and resumed the artificial respiration with energy for a short time, the natural respiratory movements meanwhile continuing; when suddenly the heart, which lay exposed before us, ceased to beat, and refused to contract again even when its muscular substance was pinched, which showed that its nervous apparatus was paralysed.

This was no doubt caused by the air becoming highly charged with chloroform in passing over the extensive evaporating surface presented by the interior of the bellows. For it had been before shown by Dr. Snow, from experiments upon the lower animals, that an atmosphere containing more than a certain per-centage of the narcotic vapour stops the heart before breathing ceases; whereas the reverse occurs when the chloroform is more diluted with air.¹ Hence, with the view of preventing fatal syncope, Dr. Snow contrived an inhaler for regulating the amount of chloroform vapour in the inspired air; and used it in upwards of four thousand cases, of which only one was fatal, and even that seemed to be so independently of the chloroform. Finding his ingenious efforts crowned with such success, and charitably supposing that all were as careful as himself, he concluded that fatal cases in the hands of others could result only from a faulty method of administration; and assuming that when chloroform is given from a folded cloth it is apt to be in too concentrated a form, he attributed most of the deaths that have occurred to paralysis of the heart from this cause.

But the cloth being the means which has been used from the first in Edinburgh, with success even superior to Dr. Snow's, I have been long satisfied that his argument was fallacious; yet as his special devotion to the subject, and the valuable facts which he has communicated regarding it, render his opinion influential, I have thought it worth while to subject a matter of such great practical importance to experimental inquiry; and, about the usual quantity of the liquid being employed, I find that, so far from the amount of chloroform given off from the cloth being in dangerous proportion to the air inhaled, the whole quantity which evaporates from the under surface, even when the rate is most rapid, viz. just after the liquid has been poured upon it, is below Dr. Snow's limit of perfect security against primary failure of the heart.²

¹ I have noticed, however, that different animals differ in their susceptibility to chloroform. Thus, frogs or mice may be kept for any length of time under its influence; but bats are very apt to die when treated in exactly the same way.

² The experiments were performed in the following manner. A cloth, similar in all respects to what would be used in practice, was supported upon a light wire framework,

But, considering the great diffusibility of the vapour, and the large amount blown away in expiration, it is evident that only a small proportion of that which comes from the lower surface of the cloth really enters the lungs. Were it otherwise, it would be extremely dangerous to give chloroform with the cloth to infants; for as they inhale but a small amount of air, they would then breathe the vapour in a very concentrated state; yet all are agreed that infants are peculiarly favourable subjects for chloroform. In truth, the quantity dissipated into the surrounding air when the cloth is used involves considerable wastefulness in this means of administration, which is its only disadvantage as compared with an inhaler; but this is abundantly compensated by its greater simplicity, and consequent greater safety. For any apparatus which has the effect of preventing the free access of the atmosphere must be liable to operate in the same deadly manner as the bellows in the case above related; and even when constructed upon the best principles, it will require most careful management, as is admitted by Dr. Snow with regard to his own inhaler.¹ On the other hand, there can be no mistake about the manner of using the cloth, which is also always at hand under all circumstances.

The theory of syncope from too great strength of the anæsthetic vapour when the cloth is employed being erroneous, the greater number of the deaths still remain unaccounted for; and, if we except a very few instances for which we seem to have nothing to fall back upon but an idiosyncrasy so rare that it may practically be left out of consideration altogether, their explanation will, I believe, be found in an overdose of this potent narcotic from too long-continued administration.

This is what might be expected from a general view of the statistics. Were we to ask ourselves in what sort of operations we should have anticipated most frequent deaths during the employment of chloroform, we should say in those which are likely to inspire great dread on account of their magnitude and severity, and to

and suspended at a little distance from the floor by a thread, connected with one end of the beam of a balance, projecting over the edge of the table on which it stood. The weight of the cloth having been ascertained, a weighed quantity of chloroform, corresponding to fl. 3jss., which is about the amount commonly used, was poured upon the middle of the lower surface of the cloth, which was then allowed to hang close above my face, so that I might breathe fully upon it, while inspiration was performed through a long india-rubber tube to avoid inhaling the chloroform vapour. The amount lost by the cloth was indicated by the weights in the scale at the other end of the beam. At the commencement of an experiment the weight was made a few grains less than the sum of the weights of the cloth and chloroform together, and an assistant noted the second when the scale with the weights in it came to preponderate; then removed ten grains so as to allow the scale to rise, and again watched the time of its descent; and repeated this process several times, thus obtaining a very accurate record of the rate of alteration in the weight. The lower surface of the cloth, which was made slightly concave, was circumstanced just as in the early period of the administration of chloroform, except that the inspired air was drawn from a distance. Inspiration does not, however, materially affect the rate of evaporation, as was found by experimenting with a cloth arranged above the mouth of a tube into which air was drawn by an appropriate apparatus. Allowance being made for the slight gain in weight that the cloth would obtain from absorbing moisture from the breath, the amount of chloroform lost from both surfaces together was thus easily determined. In order to ascertain how much escaped from the upper surface, experiments were made with the same cloth, having first the upper and then the under side securely covered with oil-silk, the arrangements being as above described, except that my face was not below the cloth. The quantity given off from the upper surface in a normal atmosphere was thus determined; and this being subtracted from the whole loss from both surfaces under the circumstances of inhalation, gave the amount that evaporated from the lower surface only. At the temperature of 70° F. this proved to be, from the average of several experiments, at about the rate of 24 grains per minute during the first half-minute; and allowing, with Dr. Snow, that 20 grains of chloroform correspond to 15·3 cubic inches of the vapour, and that 400 cubic inches of air are inhaled in a minute, we get 4·5 per cent. as the proportion of the chloroform to the inspired air, on the hypothesis that all that evaporates from the lower surface enters the lungs; 5 per cent. being what Dr. Snow was led by his experiments to regard as the proportion at which the respiration was quite sure to fail before the circulation, and that at which he aimed with his inhaler (*op. cit.* p. 34). On the other hand, Dr. Snow assumed that, when the cloth is used at a temperature of 70° F., 9·5 per cent. of chloroform is really inhaled (*op. cit.* p. 34); whereas, in truth, of the 4·5 per cent. a large amount is dissipated into the surrounding air.

¹ *Op. cit.* pp. 181, 188.

cause great shock and great hæmorrhage. More especially should these preponderate among fatal cases in general hospitals, where serious operations constitute the majority of those performed. The reverse of this, however, is what we actually find. Of the whole number of cases recorded by Dr. Snow in 1858, as due to the use of chloroform throughout the world during ten years, nine only occurred in any considerable surgical procedure at a general hospital; remarkably few, considering the enormous number of important operations that must have been performed during so long a period, and the variety in the qualifications of those who administered the chloroform. On the other hand, fourteen took place at similar institutions in connection with the most trivial matters, such as the removal of a toe-nail, the amputation of a finger, the passing of a catheter, or the cauterising of a wart. The only rational explanation of this seems to be, that when some great operation is to be performed, like the amputation of a thigh or the removal of a stone from the bladder, plenty of well-qualified assistants are present, and each of them, including the giver of the chloroform, is duly impressed with the importance of his office, and bestows the requisite pains upon it. But when some trifle is to be done, the whole affair is apt to be regarded too lightly, and the administration of the anæsthetic is perhaps confided to some unsuitable person, who also allows his attention to be distracted by other matters. This conclusion is entirely in accordance with my own experience, which, while it has convinced me more and more of the safety of chloroform if properly given, has impressed me deeply with the necessity for more vigilant care in its employment than is sometimes apt to be bestowed.

But an overdose of chloroform may be caused by attention misapplied, as well as by want of attention. The requisites for safety in using it will be best introduced by a short account of what ordinarily occurs in the mode of administration with which I am most familiar. A common towel being arranged so as to form a square cloth of six folds, enough chloroform is poured upon it to moisten a surface in the middle about as large as the palm of the hand, the precise quantity used being a matter of no consequence whatever. The patient having been directed to loosen any tight band round the neck, and to shut his eyes to protect them from the irritating vapour, the cloth is held as near the face as can be comfortably borne, more chloroform being added occasionally as may be necessary. After a time, varying considerably in different individuals, but generally longest in adults who have been accustomed to the free use of narcotics, and shortest in young children,¹ signs of excitement begin to manifest themselves in various ejaculations and muscular efforts, which soon give place to a state of complete repose. The struggles of the patient are sometimes so violent as to require considerable force to restrain them; and, for this reason, at least one efficient assistant should always be in attendance. On the other hand, I have seen chloroform induce nothing but a tranquil slumber; and it is important to bear in mind that the stage of excitement cannot be reckoned on as invariably declaring itself at all.

The most convenient test of the patient being prepared for undergoing the operation is presented by the eye; not in the size of the pupil, which is inconstant in its indications, but in what is commonly spoken of as insensibility of the conjunctiva; though in truth it has no relation to sensation, which is abolished considerably earlier; but when unconscious winking no longer occurs on the eyeball being touched with the tip of the finger, we have a good criterion of the suspension of reflex action in the body generally. At this period the pulse is in about a normal condition, and the respiration is usually either natural or very slightly stertorous, though persons

¹ I once met with an instance in which chloroform seemed incapable of affecting a patient. It occurred in the private practice of Mr. Syme, who was about to perform an operation, for which we proceeded to administer the anæsthetic; but after we had used the cloth till we were tired without any apparent effect, Mr. Syme went on with the operation while the patient was conscious. Such a case is, no doubt, excessively rare; but it is interesting as giving some colour to the hypothesis, that idiosyncrasy in the opposite direction has existed in some very few fatal cases, which seem to admit of no other explanation, as alluded to in the text.

with a strong tendency to snore may do so almost from the commencement of inhalation. But if the administration of the chloroform be further persisted in, strongly stertorous breathing will soon be induced, and will become aggravated till it passes into complete obstruction to the entrance of air into the chest, though the respiratory movements of the thoracic walls still continue. Occasionally, however, the premonitory stertor is deficient, and the breathing becomes more or less suddenly obstructed. This is a point of great importance; for without close attention it may escape notice, when the patient will be placed in imminent peril. For though the respiration may be resumed spontaneously, this cannot be relied on, and it would seem that when chloroform is given in an overdose, the cardiac ganglia are apt to become enfeebled; and on this account asphyxia produces more rapidly fatal effects under its influence than in ordinary circumstances. But if the obstructed state of the breathing is noticed as soon as it occurs, and the cloth is immediately removed from the face, and the tip of the tongue seized with a pair of artery forceps¹ and drawn firmly forwards, the respiration at once proceeds with perfect freedom, the incipient lividity of the face is dispelled, and all is well.

I am anxious to direct particular attention to the drawing out of the tongue, because I am satisfied that several lives have been sacrificed for want of it. In order that it may be effectual, firm traction is essential. I have, more than once, seen a person holding the end of the organ considerably beyond the lips without any good effect, and, placing my hand on his, have given an additional pull, that has re-established the respiration.

A simple experiment, which any one may perform upon himself, is illustrative of this point. Stertorous breathing, such as occurs under chloroform, may be produced at will, and may be carried on even while the tongue is protruded to the extreme degree. But if the tongue is laid hold of with a handkerchief and pulled so as to cause decided uneasiness, stertorous breathing of any kind becomes impossible. That further traction, when extension already exists to the utmost, should produce such an effect is an apparent anomaly, which it seemed important to explain. On investigating the subject, I noticed in the first place that stertorous breathing is of two essentially different kinds; of which one, that may be called *palatine*, consists in vibrations of the velum, and has either a buccal or nasal character, according as the air passes through the mouth or the nose; while the other, which is the profound stertor essentially concerned with chloroform, depends on a cause seated further down the throat, and, for reasons to be given immediately, may be termed *laryngeal*. By digital examination of my own throat, I found that the latter variety, and the complete obstruction into which it passes, could still be produced when the tongue was separated by a considerable interval from the back of the pharynx, while a free passage for the air existed onwards to the lips; which showed that the general belief, that the obstruction depends on a 'falling back of the tongue,' is erroneous. Also the epiglottis, instead of being folded back during the obstruction, as some have supposed, had its anterior edge directed forwards; and though it was thrown into vibrations when the stertor was strongest, it was evident that the cause of the sound was more deeply placed. I also found that, although firm traction upon the tongue abolished the obstruction and the stertor, it did not appear to produce the slightest change in the position of the base of the tongue; nor did it move the os hyoides upon the thyroid cartilage, as examined from without. Hence I was led to conclude that the beneficial effect of this procedure could not be explained mechanically, but must be developed in a reflex manner through the medium of the nervous system. The fact that, when sensation is perfect, some degree of pain is caused in the process, implying an irritation of the nerves, was in favour of this view; while the general abolition of reflex action by chloroform did not seem strongly opposed to it, considering that the reflex respiratory movements, including those of the glottis, go on in a person under the influence of chloroform.

¹ The artery forceps are the most convenient means of drawing the tongue forwards. The puncture which they inflict is of no consequence; the patient, if he notices it at all, supposes that he has bitten his tongue when under the chloroform.

For further elucidation of the matter I had recourse to the laryngoscope; and, after a little patience, found no difficulty in inspecting my own vocal apparatus without employing any depressor of the tongue, using simply the small oblique long-handled speculum and a common mirror in bright sunlight. I then ascertained that the true laryngeal stertor results from the vibration of the portions of mucous membrane surmounting the apices of the arytenoid cartilages, *i.e.* the posterior parts of the aryteno-epiglottidean folds (thick and pulpy in the dead body, but much more so when their vessels are full of blood), which are carried forwards to touch the base of the epiglottis during the stertorous breathing, and are placed in still closer apposition with it when the obstruction becomes complete. Having one hand at liberty, I was able to observe the effect of drawing forward the tongue under these circumstances, and I saw that firm traction induced the obstructing portions of mucous membrane in contact with the epiglottis to retire from it for about an eighth of an inch, so as to allow free passage for the air, while the epiglottis itself was not moved forwards in the slightest degree.¹

Whether pulling the tongue operates by inducing or relaxing muscular contraction in the larynx, may be matter for discussion; but the main conclusion, that it does not act merely mechanically, but through the nervous system, appears satisfactorily established. I have not hesitated to give the evidence on which it rests in full, as it appears to me to be of the highest practical moment. For it shows at once how grievous a mistake is committed by those who content themselves with gently drawing the apex of the tongue a little beyond the teeth, or pushing forward its base with the finger, or perhaps ascertaining that the epiglottis is not folded back. Such proceedings are instances of attention misapplied, and waste the golden opportunity for rescuing the patient from death. The proper treatment, like many other good things in medical practice, owes its origin to a false theory; but though the erroneous notion of obstruction by the tongue did good service in the first instance by suggesting the original method, it now tends to encourage supposed improvements upon it, which rob it entirely of its efficacy.

If the above description is correct; if it is true that when the administration of chloroform with the cloth is carried too far, the first serious symptom is an obstructed state of the respiration, which without watchful care may occur unnoticed, and, if allowed to continue, will endanger the life of the patient, but, if promptly treated, will harmlessly disappear—it follows that the attention of the administrator ought to be concentrated on the breathing, instead of being, as it too often is, diverted by the pulse, the pupil, or other matters still less relevant.

¹ While the true laryngeal stertor was thus produced and thus removed, a sort of spurious snoring might be made by approximation of the vocal cords; but this spurious stertor was, like the voice, quite unaffected by drawing out the tongue. These observations were made on September 21 of the present year (1861). I find that there are four ways in which the passage through the larynx may be closed. First, the folding back of the epiglottis over the opening into the pharynx, as is generally believed to take place in swallowing, and may be demonstrated by arresting an act of deglutition in its progress, and insinuating the finger between the tongue and the roof of the mouth to the epiglottis, which is then felt to be turned backwards, and to return to its usual position as the act of deglutition is finished. Secondly, an approximation of the *sides* of the superior orifice of the larynx, in which the epiglottis is directed forwards, but folded longitudinally, so that its edges are in contact with one another while the aryteno-epiglottidean folds are also in lateral apposition. This occurs in retching, and doubtless also in vomiting, when a folding back of the epiglottis, instead of protecting the larynx, would tend to direct into it the material passing from below upwards. Thirdly, an *antero-posterior* coaptation of the structures of the laryngeal aperture at a somewhat deeper level, without any change in the position or form of the epiglottis, towards which the folds of mucous membrane above the apices of the arytenoid cartilages are carried forwards, till they are in contact with its base. This is seen in coughing, and also in laryngeal stertor; and it is probable that during sleep, when the respiration is so apt to become stertorous, there is but a very narrow chink between the epiglottis and these folds of mucous membrane, which would thus serve to protect the deeper parts of the air-passages from the introduction of foreign matters in the state of unconsciousness. Fourthly, the closure of the *rima glottidis* in the production of voice. The white *chorda vocales* form a beautiful contrast with the highly vascular structures in their vicinity.

As an example of the risk that is run by want of close attention to the respiration, I may mention the following case. A surgeon of considerable experience was giving chloroform to a patient on whom an operation was being performed, of which I was a mere spectator; but I noticed that stertorous breathing came on, and gradually passed into complete obstruction, at a time when the administrator was gazing with interest upon the proceedings of the operator. Seeing that the patient was in danger, I suggested to the giver of the chloroform the propriety of pulling forward the tongue. He replied that this was uncalled for, and pointed to the heavings of the chest as evidence that breathing was proceeding freely. Knowing from what had gone before that those efforts were doing nothing for the respiratory function, and feeling that there was no time for discussion, I stepped out of my province so far as to seize the tongue myself and draw it forward, when a long and loudly stertorous inspiration demonstrated the necessity for the interference. Had the delusive movements of the chest been trusted, it is probable that they might have continued till the heart had become so enfeebled by the asphyxial state as to cause no perceptible pulse at the wrist; and had death occurred under these circumstances, the case would have been set down as one in which the circulation failed before the respiration. The administrator would thus have been absolved from all blame; and the fatal event would have been attributed to idiosyncrasy, or to any heart disease which might have been discovered on post-mortem inspection.

The very prevalent opinion that the pulse is the most important symptom in the administration of chloroform is certainly a most serious mistake. As a general rule, the safety of the patient will be most promoted by disregarding it altogether, so that the attention may be devoted exclusively to the breathing. The chance of the existence of heart disease may seem to make this practice dangerous; but having followed it myself with increasing confidence for the last eight years, and knowing that it has been pursued all along by Mr. Syme, who has also acted on the maxim that every case for operation is a case for chloroform, and must, therefore, have given it to very many patients in whom cardiac disorder existed unknown to him, besides some in whom its presence had been ascertained, I feel no hesitation in recommending it. Even when serious disease of the heart is known to exist, it must be remembered that there is much less risk of syncope than of obstruction to the respiration; and while the latter will demand and repay immediate attention, the former, should it by any chance occur, being in all probability independent of any excess of chloroform, would not imperatively demand its discontinuance; nor would it be much influenced by treatment, supposing the patient to be already in the horizontal posture, which is generally considered safest in all cases when chloroform is given.¹

From these considerations it appears that preliminary examination of the chest, often considered indispensable, is quite unnecessary, and more likely to induce the dreaded syncope, by alarming the patient, than to avert it.

The obstructed state of the breathing, if allowed to continue long, would lead to a far more serious affection—paralysis of the nervous centre concerned in the respiratory movements. Pulling out the tongue would then of course have no good effect of itself, but it should be done to clear the way for artificial respiration, which is the means to be essentially trusted to under such circumstances; and if the air still fail to enter freely into the chest, an opening ought to be made without delay through the crico-thyroid membrane. Cold water should also be occasionally dashed upon the face and chest; and if a galvanic battery happen to be in readiness, one of its poles may be applied over the spinous processes of the upper cervical vertebræ, and the other to the præcordial region, with the object of rousing the respiratory and cardiac ganglia. This, however, is a means not very likely to prove beneficial, and if used in too intense a form, it may do harm instead of good.

¹ From the views expressed in the text regarding the relation of syncope to the administration of chloroform, it might be inferred that no great danger would be incurred by giving it in the sitting posture when circumstances particularly require it; and accordingly Dr. Snow informs us that he has done this on several occasions without any bad result. But considering the possibility of an overdose, and the feebleness of the heart which that seems to entail, it is no doubt wisest, as a general rule, to have the patient reclining. Dentists, if it is true, give chloroform in the sitting posture; but, so far as I have seen, they do not carry the administration beyond a slight degree, sufficient to deaden sensation without affecting reflex action, dexterously managing to open the mouth and operate upon it while the muscles of the jaws are rigid.

Preparatory to taking chloroform the patient should be directed to omit the last meal which would naturally precede it, as any food in the stomach is almost sure to give rise to troublesome vomiting during the inhalation. The only after treatment necessary is to allow the effects of the chloroform to pass off in a quiet sleep; and the only bad consequence likely to arise is a tendency to sickness, which sometimes causes annoyance during the first twenty-four hours or so.¹

Chloroform is universally applicable in the various departments of surgery, except in some few cases in which the assistance of the patient is required, and in operations involving copious hæmorrhage into the mouth. Blood may trickle in small amount into the pharynx without risk of choking, deglutition being carried on unconsciously during anæsthesia; and even in some instances when the bleeding is more serious, as in removing portions of the jaws, pain may be avoided to a great extent by giving the chloroform during the more superficial parts of the operation, and allowing the patient to recover partially before undertaking its deeper stages.

The main conclusions arrived at in this article may be expressed in a few words. It appears that chloroform, though resembling many other valuable means of treatment in being deadly when mismanaged, is free from danger if properly used; the following being the rules for its safe administration. A drachm or two of the liquid having been sprinkled upon the middle of a folded towel, hold it near the face, taking care that free space is afforded for the access of air beneath its edges, till the eyelids cease to move when the conjunctiva is touched with the finger. Meanwhile watch the breathing carefully; and if at any time it should become obstructed or strongly stertorous, suspend the administration and draw the tip of the tongue firmly forwards till the tendency to obstruction has disappeared.

These simple instructions may be acted on without difficulty by any intelligent medical man. The notion that extensive experience is required for the administration of chloroform is quite erroneous, and does great harm by weakening the confidence of the profession in this valuable agent, and limiting the diffusion of its benefits.

PART II. WRITTEN 1870.

The nine years which have passed since the above article was written have tended to confirm its main doctrines.

The safety of chloroform when administered according to the rules laid down in the preceding pages has hitherto been verified without exception in my own personal experience; and I may add that Mr. Syme, though he continued to within the last two years in the full activity of his career as an operator, never lost a patient through its use, either in public or private practice. Further, I believe I am correct in stating that no case of death from chloroform has occurred during these nine years, in the operating theatre of either the Edinburgh or the Glasgow Infirmary, two of the largest surgical hospitals in Great Britain. Yet in both these institutions a folded towel on which the anæsthetic liquid is poured, unmeasured and unstinted, is still the only apparatus employed in the administration: preliminary examination of the heart is never thought of, and during the inhalation the pulse is entirely disregarded; but vigilant attention is kept upon the respiration, and in case of its obstruction, firm traction upon the tongue is promptly resorted to. And it is worthy of special notice, as showing that success is due to soundness of the principles acted on, rather than any particular skill, that the giving of the chloroform, instead of being restricted to a medical man appointed for the function, as is else-

¹ It has been supposed by some that the use of chloroform increases the risk of pyæmia after capital operations; but experience has now abundantly proved the groundlessness of this apprehension. To take a single instance, the veins of the pelvic viscera being perhaps, next to those of the bones, more liable than any others to originate phlebitis after surgical interference, lithotomy would be much more fatal now than formerly, were there any foundation in fact for the notion. The reverse, however, appears to be really the case. Thus, Mr. Cadge, one of the surgeons of the Norfolk and Norwich Hospital, an institution long celebrated for the successful treatment of stone, in a district abounding in calculous disease, informs me that the mortality after lithotomy has been still further reduced there since the introduction of chloroform.

where often thought essential, is entrusted to the junior officers of the hospital. In Edinburgh each of the five surgeons has two 'clerks,' intermediate in position between the house surgeon and the dressers. They, besides other duties, take it in turn to administer the anæsthetic; and if I had to be placed under its influence I would rather trust myself to one of these young gentlemen than to the great majority of 'qualified practitioners.'

The appointment of a special chloroform-giver to an hospital is not only entirely unnecessary, but has the great disadvantage of investing the administration of chloroform with an air of needless mystery, and withholding from the students the opportunity of being trained in an important duty, which any one of them may be at once called upon to discharge on commencing practice, and which, though certainly simple, is better performed after some practical initiation. I well remember the anxiety I felt on entering upon office as Mr. Syme's house surgeon, though I had before held a similar position in London, lest his first fatal case should occur in my hands; but this feeling soon gave place to perfect confidence, more especially after I had seen symptoms which would before have alarmed me, dispelled at once by traction on the tongue, which was then a novelty to me, and which is, I fear, even yet not duly appreciated by the profession generally.

An incident which occurred during my Glasgow incumbency illustrates so strikingly both the value of drawing forward the tongue, and the relations of the circulation and the respiration to chloroform, that it seems right to place it on record. One of my colleagues in the Infirmary had been making an attempt to reduce a dislocation by means of the pulleys, chloroform having been given very fully by the house surgeon, who, at the close of the performance, removed the cloth from the patient's face, and proceeded to attend to other matters. Happening to be present, and observing that the respiration was deeply stertorous, I watched it carefully, and noticed that it passed almost immediately into the state of complete obstruction, though still accompanied by the movements of the thorax, the face meanwhile becoming markedly livid. Unwilling to interfere, and seeing the carotid pulsation conspicuous in the neck, I waited awhile, hoping that the obstacle to the breathing would disappear spontaneously. But instead of this I soon saw to my horror the lividity give place to what I knew was physiologically identical with *post-mortem pallor*. I now rushed forward and drew the tongue out firmly with the artery forceps; air at once passed into the chest, and the man was rescued.

This case seems to me fraught with the deepest instruction.

There can be no doubt that the patient was on the very verge of death; that if the laryngeal obstruction had lasted a very short time longer, the respiratory and cardiac ganglia would have failed in their functions. Supposing the administrator to have continued the chloroform with his attention devoted to the circulation, the first thing that would have alarmed him would have been the failure of the pulse at the wrist. On removing the cloth from the face, he would have seen the deadly pallor; and, ignorant of the asphyxial lividity which had preceded, he would have taken it as positive evidence of primary failure of the heart; a verdict in which the whole profession would probably have supported him, whether valvular disease or fatty fibres could or could not be discovered on post-mortem inspection. The case, then, reads us another striking lesson on the paramount importance of taking the respiration as our guide, and shows how readily, if this be not done, a death due to the grossest mismanagement may be regarded as the inevitable result of constitutional peculiarity.

The case also shows the necessity of keeping watch for a while after the administration has been discontinued. The last portions of the vapour inhaled seem to take some seconds at least before they produce their full effects on the nervous centres; and the patient should not be left till he has been seen to breathe calmly and freely for some minutes after the cloth has been removed.

On one occasion only, so far as I remember, have I seen firm traction on the tongue fail to remove laryngeal obstruction. In that instance the chest continued to heave, but no air entered or escaped, although the tongue was well drawn out. Happily, however, the desired effect was instantly produced by slapping the face with a towel dipped in cold water, while the traction on the tongue was maintained. This fact is interesting, not only as a striking illustration of the value of the sudden application of cold under such circumstances, but also because it confirms the explana-

tion before given of the *modus operandi* of traction on the tongue, viz. that it operates not mechanically, but through the nervous system. For here the barrier to the entrance of air into the chest remained in spite of the clearing away of any obstacle which the tongue might be supposed to present, but that barrier was at once removed by a means which could not act in any other way than through the nerves.

It is nevertheless true that the tongue does frequently fall back under chloroform, and so occasion a mechanical impediment to respiration. It recedes, no doubt, in consequence of relaxation of the lingual muscles; and accordingly thick or obstructed breathing depending on this cause may be very simply cleared by pulling the beard or forcibly pushing up the chin, so as to draw forward the tongue through the medium of the muscular fibres which pass back to it from the maxilla. Turning the patient's face well round to one side, so as to cause the weight of the relaxed organ to tell laterally rather than backwards, is another way in which a needless puncture of the tongue may often be avoided. But it must always be borne in mind that neither of these means can be expected to succeed if the obstruction exists in the larynx, and if they do not answer their purpose, not a moment should be lost in applying the artery forceps.

Whenever it is necessary to draw the tongue forward, it is of course equally needful to suspend the administration, by taking the cloth entirely away from the neighbourhood of the face. To act otherwise would be to pour in a fatal dose after artificially removing the natural safeguard against its entrance. To give a caution against so obvious a breach of physiological principle may seem superfluous, but I know by experience that it is not uncalled for.

I have admitted in the foregoing article that idiosyncrasy may have been the cause of death in some anomalous cases which have been put on record. We certainly see strange varieties in the effects produced by chloroform both on the cerebral and the spinal centres. Some persons when inhaling it lie from first to last as in a tranquil slumber; some, before they succumb to its narcotic influence, struggle with great violence, without uttering a sound; others bawl lustily, while some sing sweetly, and others again are disposed to converse quietly though incoherently with those around them. There are also remarkable differences in the relation of sensation to consciousness under chloroform. As a general rule they are affected simultaneously, but we now and then see patients insensible to the pain of an operation, though perfectly conscious of all that is passing. Equally various are the effects upon the spinal functions. The absence of winking when the eyeball is touched with the finger, though a very good general guide to the abolition of reflex action in the body generally, is by no means an unvarying indication. In some persons that particular function is abolished earlier or later than usual. Relaxation of the sphincters of the bowel and bladder is a result of chloroform happily only occasionally met with, and various other instances of exceptional phenomena might be mentioned. Another example of peculiarity, more closely bearing upon the question of death from chloroform, has come under my observation in two instances during the last nine years, viz. cessation of the movements of the thorax, or in other words suspension of the function of the respiratory ganglia, without any preliminary laryngeal obstruction; although there was not, so far as I could judge, anything unusual in the mode of administration. In both cases natural breathing soon returned under artificial respiration maintained by intermitted pressure on the false ribs, while the tongue was drawn forward, accompanied by occasional slapping of the face and chest with a cold wet towel. But the condition was sufficiently alarming while it lasted. The patients were both elderly, feeble subjects: and I may remark that if I ever give chloroform with any degree of apprehension, it is to the aged and infirm.

Another closely allied instance of idiosyncrasy once presented itself in my practice. I had removed under chloroform a small epithelial cancer from the eyebrow of a feeble old woman, nothing unusual having occurred, when I noticed that the breathing assumed a peculiar sighing character, and the intervals between the sighs became greater and greater, till I began to fear their entire cessation. However, normal respiration returned, and in the course of a few minutes she got up and sat in a chair beside the fire. But she had not been

there long before the same strange slow breathing came on again, as if she would sigh her life away ; and I believe that if I had not had her put back promptly to bed, she would actually have died. Here a feeble frame was further weakened by the potent narcotic, and it happened that the effect told especially upon the respiratory function, with the peculiarity that it was manifested not during the administration of the chloroform, but subsequently.

With these examples before us of deviations from the usual order in which the various functions of the nervous system are affected by chloroform, no one can say it is impossible that here and there an individual may be found so constituted that, without any undue proportion of the narcotic vapour to the air inhaled, the cardiac ganglia may fail before the respiration is interfered with. But while freely admitting that such a thing is possible, I must repeat my firm conviction that this kind of idiosyncrasy is certainly 'so rare that it may practically be left out of consideration altogether.'

The danger of chloroform may be compared, not inaptly, to that of railway traveling. In both cases the risk incurred by any individual is so small that it does not enter seriously into our calculations. And just as railway accidents are generally occasioned by culpable mismanagement, so death from chloroform is *almost invariably* due to faulty administration.

Various attempts have been made during the last nine years to improve our anæsthetic methods. Among these must be mentioned the reassertion of the claims of sulphuric ether by the late Dr. Mason Warren, of Boston, in America. Our transatlantic brethren naturally feel indignant that their grand discovery of anæsthesia in surgery should be confounded with the very secondary matter of finding out that a different agent from that which they employed will produce similar effects in a more efficient manner. For the introduction of chloroform, when the whole subject was a novelty, led to a confusion in the public mind in this country, where 'the discovery of chloroform' is often regarded as identical with the discovery of anæsthesia. And there can be no doubt that if sulphuric ether were still in use in Britain as it is in Boston, and if chloroform were now brought forward for the first time as a substitute for it, comparatively little would be thought of the innovation. More convenient chloroform undoubtedly is, on account of its smaller bulk, and the greater facility of its administration ; but Dr. Warren contended that these advantages were more than counterbalanced by the greater safety of ether, which he declared had never up to the time of his writing produced a single death.¹ Admitting the facts to be in the main as Dr. Warren has given them, the case may probably be fairly stated by saying that ether, being less potent, is less liable to cause death from mismanagement. But the rules for the satisfactory use of chloroform are so simple that mismanagement is really inexcusable ; and if we had nothing else to consider than the question of safety, chloroform would probably in all cases maintain its superiority over ether. There is, however, another point in which a great advantage has been lately claimed for the original anæsthetic. The vomiting which is so frequent after chloroform is generally only a matter of more or less inconvenience. But in the special case of ovariotomy the disturbance of the abdomen thus occasioned is thought to have sometimes been the cause of death. Dr. Thomas Keith, whose remarkable success in that operation is well known, was led to try sulphuric ether, in the hope that it might prove less objectionable in this respect ; and the result has been in the highest degree satisfactory, so that whereas with chloroform vomiting was the general rule, it now seldom occurs in his practice.² Dr. Keith has also ascertained that if truly anhydrous ether be employed, it can be given so as to produce its effect almost as rapidly as chloroform, and without waste of the material, by simply pouring a little of the liquid occasionally upon a piece of flannel contained in a cup-shaped vessel adapted to the mouth and nose, with a small aperture for the entrance and exit of air. Hence, as there are various other operations in which the avoidance of vomiting is a matter of great moment, sulphuric ether seems likely to reassume an important place as an anæsthetic.

¹ See *Surgical Observations, with Cases and Operations*, by J. Mason Warren, M.D. &c.

² See *The Lancet*, August 20. 1870.

Nitrous oxide, which we had looked upon as of mere historical interest, as a kind of pioneer in anæsthesia, has also been revived of late years and turned to practical account, chiefly through the exertions of Dr. Evans, an American dentist residing in Paris. It is a remarkable fact, that when inhaled unmixed with atmospheric air, it fails to produce the excitement to which it owes the name of 'laughing gas;' but merely throws the patient very rapidly into a condition of complete coma, attended with great lividity of the face, and staring dilatation of the pupils, presenting a very alarming appearance when seen for the first time, but, as experience shows, free from danger, subsiding as rapidly as it supervened, and leaving in the great majority of cases no trace of sickness or other unpleasant effects. The agent has recently been rendered much more portable by keeping it stored in the liquid form in a strong cast-iron bottle, from which, by turning a stopcock, the gas is supplied to an india-rubber bag, large enough to contain about an average dose for producing insensibility. When this is exhausted, the balloon can be refilled in the same way as often as may be desired, and thus it is possible by a series of intermitted administrations to keep a patient under the influence of the gas for a protracted period. It is questionable, however, whether nitrous oxide, if employed for producing long-continued insensibility, would prove as safe as chloroform, and it is pretty generally admitted that its legitimate place is for operations of very short duration. But for avoiding the brief but acute agony of tooth-extraction, it appears to be an unquestionable boon to humanity.

The benumbing influence of cold was brought into requisition several years ago by Dr. James Arnott for producing local anæsthesia, by means of a freezing mixture of pounded ice and common salt.¹ The same object has since been more efficiently attained by Dr. B. W. Richardson, by ingeniously availing himself of the reduction of temperature occasioned by evaporation. Anhydrous sulphuric ether intimately mingled with air in the form of spray is projected upon the part by means of a suitable apparatus easily worked by the hand. In a few seconds the skin upon which the spray plays suddenly assumes a snow-white colour, implying that its surface is completely frozen. It is well to continue the application for a little while after this change has occurred, in order to ensure the penetration of the effect to a sufficient depth. The frozen parts may then be incised or operated on in any way that may be desirable, without the slightest pain to the patient, and the tissues when thawed are generally as well disposed for healing as usual.

This method is necessarily of limited application. It is only adapted for superficial operations, and even for many of these the rigidity of the tissues occasioned by congelation is inconsistent with efficiency of performance; as in removing epithelial cancers, where the sense of touch is the principal guide for the surgeon; or, again, in taking away thin-walled atheromatous cysts, where looseness of the surrounding cellular tissue is essential to satisfactory dissection. Nevertheless there are many cases, such as the incising of a boil or the removal of the nail of the great toe, in which this means of producing local anæsthesia proves perfectly satisfactory. In operating on the extremities I have found great advantage from restraining the circulation with a tourniquet, so as to prevent the oozing of hot blood, which would otherwise interfere with maintaining the frozen condition or extending it to deeper parts.

PART III. WRITTEN 1882.

Since Part II. of this article was written, twelve years ago, ether, on account of its supposed greater safety, has to a large extent superseded chloroform in the practice of many British surgeons. At the same time the manner of administering it has undergone a remarkable change. Instead of a free admixture of atmospheric air, such as is essential to safety in giving chloroform, partial asphyxia is systematically combined with the toxic influence of the anæsthetic, by making the patient breathe over and over again the same air contained in a balloon of caoutchouc, a

¹ See *The Lancet*, October 30, 1858.

reservoir of ether being interposed between the balloon and a closely fitting mask over the mouth and nares. This may for convenience be termed the *close* method of administering ether, as distinguished from all varieties of what we may call the *open* method, in which fresh air is admitted with each inspiration. It was introduced by Dr. Ormsby of Dublin, and was brought to great perfection by the late Mr. Clover. Various advantages are claimed for it. It certainly greatly economises the ether, and brings the patient very rapidly under its influence. It is also said that by utilising the warmth of the expired air, and thus diminishing the great coldness of the inspired air occasioned in the open method by the rapid evaporation of the ether, it prevents a chilling of the lungs which sometimes led to serious and even fatal after effects in the form of acute bronchitis or pulmonary œdema or congestion.¹ There can be no doubt that this constituted a real danger of the open method. A striking example of death taking place unusually rapidly from this cause is given in the '*Lancet*' of April 1 of the present year (1882) from a report furnished by Dr. Parsons, of New York, in whose practice the case occurred. A healthy woman 54 years old had ether given for the reduction of a dislocation of the shoulder of 5 weeks' standing, the operation lasting 25 minutes. She took the ether well, about 6 fl. ounces being administered. Five minutes after the reduction was effected she took some water, and about an hour and a half later Dr. Parsons left her apparently well. After the lapse of another half-hour, however, the house-surgeon found her cyanosed; and in spite of active stimulating treatment she died in the course of another hour. On post-mortem examination the organs generally were found healthy, but the lungs were deeply congested. No mention is made of the mode of administration; but from the quantity of ether used we may infer that it was some form of the open method. Such occurrences are not generally published, but they would appear to be by no means very uncommon. A case of death from acute bronchitis after an operation on the eye for which ether was given by the open method was mentioned to me lately by a surgeon in whose practice it occurred, and who had no hesitation in attributing the fatal result to the ether. Mr. Hodges of Leicester, writing in the '*Lancet*' of July 15, 1882, says, 'As regards deaths from ether, I make no doubt many occur which are never reported, for the simple reason that the death, instead of being instantaneous (as in the case of chloroform), occurs some hours later from bronchitis. At any rate, there have been two such deaths from ether at the Leicester Infirmary during the last nine years, against two from chloroform in the same period.' It is scarcely necessary to remark that a fatal event brought about in this manner, though less appalling, is as much a death from ether as if it occurred on the operating table.

It would not be right, however, to look upon the close method as simply the open method deprived more or less of the risks attendant on chilling of the lungs. The close method is, as before remarked, a combination of partial asphyxia with etherisation, and constitutes a new departure in anæsthesia which must be judged of independently.

From experiments which have been performed upon some of the lower animals it has been inferred that there is an essential difference between ether and chloroform as regards their action upon the heart: that whereas chloroform, after a brief period of stimulation, depresses it, ether for a long time fails to produce any lowering influence, or even acts as a persistent cardiac stimulant,² and this has been held to afford clear proof of the greater safety of ether.

There can, however, be no doubt that any agent capable of producing anæsthesia must, if continued in operation for a considerable time, exercise a lowering effect upon the whole vital powers. Ether, moreover, has its own special risks. Its vapour has an irritating effect upon the air-passages, such as is not caused by chloroform. Hence it increases the bronchial secretion, and tends to produce asphyxial complications; so that even its warmest advocates do not advise its employment when the respiration is seriously embarrassed, as in chronic bronchitis or emphysema. But asphyxia, even

¹ See Teale, *British Medical Journal*, March 11, 1882.

² See Report of a Committee of the Medico-Chirurgical Society, *Med.-Chir. Trans.* vol. xlvii. 1864, p. 335.

when carried to a minor degree, has a depressing effect upon the circulation; and accordingly on reading reports of death from ether, we often find it stated that the pulse and breathing ceased simultaneously.

In the close method of administration, anæsthesia being only partly brought about by the ether, asphyxial complications due to the action of the ether *per se* are necessarily less than in the open method. But, on the other hand, the partial asphyxia by which the action of the ether is supplemented in the former method, has a lowering effect upon the circulation. Hence a stimulating action of the ether upon the heart can by no means be reckoned on when this method is employed. On the contrary, the pulse may become, within a very short time, greatly reduced in force. This is illustrated by the instructions which accompany Mr. Clover's smaller inhaler as supplied by Messrs. Krohne and Sesemann, in which the following sentences will be found: 'If any interruption in the breathing occur, or *if the pulse should be indistinct*' (the italics are mine), 'the face-piece need only be removed for one inspiration. The dark colour of the blood is a less reliable test of the need of air than the symptoms mentioned.' We cannot, therefore, be surprised to find that occasionally death takes place under this method of administration by primary failure of the heart.

In the 'British Medical Journal' for July 15 of the present year Mr. Lawson Tait has put upon record what seems a perfectly clear example of such an occurrence. The patient, aged 45, was sent to Mr. Tait to be operated on for a large abdominal tumour. She was at first very anæmic and feeble, but improved in the hospital, so that it was decided to proceed to operation. She was placed under ether by means of Ormsby's inhaler, but before complete anæsthesia had been produced, Mr. Tait, who was observing the pulse, noticed that it had disappeared. Meanwhile 'the breathing was perfectly regular and deep.' The inhaler was at once removed, but in spite of artificial respiration, with lowering of the head, the breathing rapidly failed. 'Death took place at the heart at least one minute before the respiration was interfered with.' On post-mortem examination the right side of the heart was found filled with clot, and the left side empty. The muscular substance was not distinctly diseased, but the organ was unusually small.

As a matter of physiological theory, supposing the heart to be diseased, and therefore liable to have its rhythmical action suspended by comparatively trivial disturbing causes, we could well understand that the unusual labour thrown upon the right side of the organ by asphyxial impediment to the pulmonary circulation might prove extremely serious, even in spite of a stimulating action of the ether upon it.

With regard to chloroform I fear some of the more recent experiments upon the lower animals have had an injurious practical tendency. Since the time of Dr. Snow we have understood that there is a most important difference in the effects of chloroform according to the proportions in which the vapour is mixed with the air inhaled: that when it is present in a concentrated form, it acts as a deadly sedative upon the heart; but that when largely diluted with the atmosphere, this effect is no longer observed, but if the agent is pushed far enough to cause death, the respiration probably fails before the circulation.

Yet in the experiments conducted by the Committee of the British Medical Association appointed to inquire into this subject, the question of the proportion of the anæsthetic to the air seems to have been entirely neglected. Starting with the assumption that chloroform, from its depressing influence upon the heart, is more dangerous than ether, while ether is much less convenient for administration, the attention of the Committee was chiefly directed to an endeavour to discover some agent intermediate between them in these respects; and such they found, as they believed, in ethidene dichloride, which they accordingly recommended as preferable to either of the others. But in order to ascertain the relative effects of the different substances upon the heart, they used them all in a very concentrated form, the air being in many of the experiments made to bubble through the liquid contained in a Wolfe's bottle on its way to a tube tied into the trachea; so that, to quote the words of the Committee, 'the air passed into the animal's lungs was saturated with the vapour of the substance used.'¹ Hence these experiments, though very interesting from the new facts which

¹ See Report on the Action of Anæsthetics, &c., *Brit. Med. Journ.* Dec. 18, 1880, p. 957.

they elicited regarding 'ethidene,' and valuable as respects ether, by showing that it may be safely given, so far as the heart is concerned, in a very concentrated form, have really little bearing upon the use of chloroform in the human subject, where it is well understood that the agent must be given largely diluted with air.

But these researches, by placing before the profession in an exaggerated form the effects of chloroform as a cardiac sedative, have tended to foster the idea that if chloroform kills, it always does so from the heart, and that the pulse is the main thing to be attended to in its administration.

Against this pernicious error I have endeavoured in the earlier parts of this article to raise an emphatic protest. I have pointed out how liable the breathing is to become obstructed under chloroform, whether by the falling back of a relaxed tongue or by closure of the valve of mucous membrane which guards the orifice of the larynx; and further, how obstruction from either of these causes may occur without premonitory stertor, in an insidious manner requiring the utmost vigilance for its detection; so that, unless the attention is fixed upon the respiration, mere heaving of the chest and abdomen (which will continue long after air has ceased to enter the lungs), though doing nothing for the respiratory function, may be mistaken for effective breathing; the patient meanwhile being exposed to the serious dangers which attend a combination of asphyxia with the effects of chloroform. On the other hand, I have contended that if the breathing is carefully observed, and the obstructions referred to are removed as soon as they occur, due care being taken to avoid pushing the agent beyond what is needful to produce its anæsthetic and relaxing effects, the chloroform being given well mixed with the air by means of a folded towel held loosely over the face, all fear of primary failure of the heart may be dismissed from the mind.

The experience of the last twelve years has confirmed me in the soundness of this doctrine; and I venture to think it not undeserving of careful consideration, that in my hospital cases I have still entrusted the administration of the chloroform, not to a specialist or to a person of very large experience, but to a succession of senior students, changing from month to month, whose only qualification for the duty is that they must previously have served the office of dresser, and that they strictly carry out certain simple instructions, among which is that of never touching the pulse, in order that their attention may not be distracted from the respiration. I have also systematically abstained from making any preliminary examination of the heart, thus avoiding needless alarm, which we know to have been the cause of some fatal events both with chloroform and with ether.¹ Such has been my practice since I first obtained the office of full surgeon to a large hospital twenty-one years ago, and I have never had reason to regret it.

During this long period I have often operated upon patients known to be affected with disease of the heart, and among the rest there must necessarily have been included many affected with fatty degeneration of its muscular fibres, which is regarded as the most formidable condition with reference to chloroform.

It happened not long ago that an elderly lady, whose mamma I removed for scirrhus, died a few days after the operation from the singular complication of perforation of the duodenum by an ulcer caused apparently by the irritation of gall-stones. She had taken the chloroform quite well; but I found on post-mortem examination that the heart was affected with as extreme a degree of fatty degeneration and at the same time thinning of the ventricular walls as I could well imagine to be consistent with the maintenance of the circulation.

Such being my own experience, and well knowing how apt the administrator is to fail to notice the insidious obstruction of the respiratory passages, I cannot help believing that in many of the cases reported in the journals where primary failure of the heart is stated to have occurred, mere respiratory movement without respiratory function has been mistaken for true breathing continuing after cessation of the pulse.

It is, alas! true that I can no longer speak of never having had in my own

¹ For an instance of death from fright at the commencement of the inhalation of ether, see *Brit. Med. Journ.* Nov. 17, 1877; case reported by Dr Lowe, of Lincoln.

experience a death occasioned by chloroform. One unmistakable instance of this fearful calamity occurred lately in my private practice. But the circumstances were such as seem to me to preclude the idea of syncope. They were as follows:—

A strong, healthy man, 27 years of age, came under my care with a lumbar abscess unconnected with the vertebræ. I proposed to open it under chloroform, which was administered from a folded towel. The patient struggled rather more than usual during the administration, which had not been carried to the degree of producing muscular relaxation when he began to make a spurious snoring or snorting noise, which is generally a sure indication that the patient requires more chloroform. Mr. Watson Cheyne, who was giving the chloroform for me, had, however, removed the cloth from the face, and I was about to remark that this was an unnecessary precaution, when the patient fell into a sort of epileptiform condition, attended with a state of spasm of the respiratory muscles and wide dilatation of the pupils, while the face was deeply livid. As no respiratory movements were going on, I had him drawn up on the table so as to make the head dependent, and commenced artificial respiration, while the tongue was drawn forward with artery forceps. The chest, however, seemed fixed in the state of expiration, so that compression of the thorax caused no escape of air, while the drawing up of the arms equally failed to cause the entrance of any. I have frequently performed artificial respiration, but never before met with such a state of things. Cold water was dashed upon the chest and abdomen, and, whether as a consequence of this or not, two spasmodic acts of inspiration took place, separated by a considerable interval. I opened the trachea, but in the condition of the thoracic walls which I have described, this procedure was in itself completely futile. Some little time having been lost in vain attempts at artificial respiration, I passed down the trachea from the wound a piece of wide india-rubber tubing several inches long, and by blowing into this succeeded in inflating the lungs, as was indicated by rising of the abdomen and very slight elevation of the ribs, and I continued artificial respiration in this way for about half an hour in vain. The pulse had been observed to be good just before the occurrence of the alarming symptoms. What its condition was during their presence we were too much occupied to ascertain; but the great lividity of the face, and indeed of the whole body, clearly indicated that the heart continued to drive imperfectly oxygenated blood through the vessels long after the respiration had been arrested by muscular spasm. We obtained permission to examine the heart twenty-four hours after death, and found its muscular substance abundant and healthy, and its valves all competent. With the exception of some spots of slight opacity on the mitral valve, it was a thoroughly healthy heart. Its cavities contained fluid blood; and this escaping on the removal of the organ from the body, the relative amount in the cavities of the two sides was not ascertained. I afterwards learned that the patient had been in a state of extreme terror at the prospect of taking the chloroform; and I suspect that this may have been the cause that determined the occurrence of the strange state of nervous excitement which proved fatal to him. By a curious coincidence it happened that the medical man who recommended this patient to my care, on learning of our disaster, wrote to me stating that a short time previously he had met with a very similar state of epileptiform spasm of the respiratory muscles in a man in whom he was examining a simple fracture without chloroform. It lasted so long that my friend considered that it was on the verge of proving fatal. Of course in my case the chloroform was the cause of the fatal event; but my impression is that it would have been as likely to happen under any other anæsthetic.

Quite recently the subject of the different effects produced by an anæsthetic, according to the proportion which it bears to the air in which it is diffused, has been brought forward in an exceedingly striking manner by Monsieur Paul Bert. Experimenting in a manner essentially similar to that adopted by Dr. Snow, diffusing various quantities of the anæsthetic in air contained in a vessel of known capacity, so large as to avoid all chance of asphyxial complications, he has arrived at remarkable conclusions. So far as I can gather from the very brief account which he has published (*Comptes Rendus*, Nov. 14, 1881), he concludes that there is a certain percentage below which chloroform fails to produce any anæsthetic effect, however long it continues in operation; that there is another percentage, at or above which it proves mortal (*l'animal finit par mourir*); and that between these two definite proportions there is a 'workable zone' ('zone maniable') which produces anæsthesia, but does not kill; and when the quantity of chloroform is such as to be about the middle of this *zone maniable*, the animal is rapidly anæsthetised ('il est très rapidement anesthésié'), and yet may be safely left for an indefinite time in the same atmosphere (the experiment was sometimes continued as long as two hours), 'sans qu'on ait à s'occuper ni à s'inquiéter de lui.' Curiously enough, the smallest mortal proportion was just double the smallest anæsthetic quantity; and this held for all kinds of animals, although the absolute amount differed for different species. And

the same law obtained with ether, bichloride of methylene, and other anæsthetics which were made the subjects of experiment.

These views are so startling that, if it were not for M. Paul Bert's high scientific reputation, we should be disposed to disregard them altogether. There can, however, be no doubt of their great importance if correct; and I have endeavoured to test their accuracy by some experiments similar to his with one of the species which he employed, viz. the mouse: and though my experience is very limited, being confined to results obtained from a single family of white mice, yet it seems deserving of mention.

There were four young ones just ready to leave their dam, and I found, as Dr. Snow had done, that the young animals of this species were more tolerant of chloroform than the adult. The creature was in every case introduced into a large glass jar of known capacity, containing air through which a certain percentage by weight of chloroform had been thoroughly diffused, assuming one hundred cubic inches of air to weigh thirty-one grains, which for practical purposes was sufficiently accurate.

Seven per cent.,¹ which is the middle of Paul Bert's *zone maniable* for the mouse, proved much too strong for my animals: causing complete arrest of the breathing in one of the young ones in a quarter of an hour, though it recovered on being at once withdrawn from the chamber. An adult, the father of the family, was killed by the same percentage in four minutes, and, the chest being at once opened, the heart was found to have entirely lost its irritability, failing to contract when pricked with a needle. This percentage, then, was clearly within Paul Bert's mortal zone for these white mice. Four per cent. (4·9 being the extreme lower limit of Paul Bert's *zone maniable* for the mouse) caused complete anæsthesia in three minutes and a half in another of the young animals; and this atmosphere being continued in operation produced a progressively lowering effect upon the breathing, which was reduced in the course of one hour and twenty minutes from two hundred per minute to twenty-eight shallow and irregular respirations, after which the animal died. The heart was, however, found beating when the chest was opened twenty minutes later, and the exposed organ continued to pulsate even for another hour, showing how little its power had been affected by the chloroform in the more diluted state.

The experiments being continued on the following day, three per cent. of chloroform rendered one of the young animals completely passive in two minutes and a half; and within four minutes it had brought the respirations down to seventy-eight, and in the course of one hour and three-quarters reduced them to about twenty feeble and irregular movements; after which they ceased entirely, and did not recur, although the animal was withdrawn from the chamber within two minutes and a half of their cessation. The more rapid anæsthesia and greater depression of the respiration occasioned by this smaller percentage of chloroform are, I believe, to be explained by a feeble state of the animal, caused by its having been the subject of the first experiment on the previous day. The fact illustrates the different susceptibilities to chloroform that may be presented by the same individual under different circumstances.

Two per cent., tried with another of the young mice, made the animal stagger in about two minutes, but failed to produce complete anæsthesia in an hour; and at that time the respirations continued as high as one hundred and sixty per minute. But after the lapse of another hour anæsthesia was found to be complete, and the respirations reduced to eighty-six. In the course of two hours more the breathing was further lowered to fifty-six, and it was evident that death would occur in no long time if the animal were kept in the same atmosphere. It was removed, and recovery took place, but only very slowly, no movement of the limbs showing itself for nearly an hour.

Lastly, a percentage intermediate between those of the last two experiments was tried, viz. two and a half. It produced anæsthesia somewhat slowly in the young animal subjected to it, requiring a quarter of an hour for complete relaxation. The respirations meanwhile had come down from about two hundred to one hundred and sixty-eight, and after the lapse of twenty-two minutes more, had fallen to one hundred and four. The animal was now left unobserved in the chamber for another hour, and at the end of that time it was found dead. It will be observed that two and a half per cent., though it anæsthetised more slowly, yet killed sooner than four per cent. had done on the previous day. The subject of the experiment had, I fear, been weakened by being kept in less favourable hygienic conditions since it was got from the dealer the day before.

The facts elicited by these experiments, though not numerous, seem to me instructive. In the first place, they afford an illustration of Dr. Snow's important principle, that there are two essentially different ways in which chloroform may kill;

¹ It is to be borne in mind that the percentage by weight is a totally different figure from the percentage by volume used by Dr. Snow and adopted in Part I. of this article, the vapour of chloroform being 4·2 times heavier than air.

viz. by a directly sedative action on the heart when the chloroform is in large proportion to the air, and by a suspension of the respiratory function, while the heart is still acting, when the chloroform is largely diluted. They also show how different individuals of the same species, and even the same individual at different times, may differ in susceptibility to chloroform. And in the third place they indicate, I fear, but too plainly, that we cannot by any means trust implicitly to the existence of Paul Bert's three distinct zones. For we have seen that a proportion of chloroform which produced anæsthesia so extremely slowly that, if it was within the anæsthetic zone at all, it must have been at its very lowest limit, nevertheless exerted a gradually increasing deleterious influence, tending at last to a fatal result. And when the proportion was increased so as to make any approach to the 'very rapid' anæsthetising effect which, as M. Bert tells us, characterises the middle of the *zone maniable*, a similar but more rapid deleterious action was observed, causing death considerably within the two hours referred to by M. Bert. We see, therefore, that, for those animals at least, there existed no efficiently anæsthetic mixture of chloroform and air which could safely be left in continuous action for such a length of time as is not unfrequently occupied by a surgical operation.

Hence, whether we regard the various degrees of susceptibility to chloroform shown by different individuals, or the sure though gradual lethal effects of even the smallest proportion which suffices to be anæsthetic, I fear the proposal which I understand M. Bert to make, that the *zone maniable* having been ascertained for man, a corresponding atmosphere should be provided in a large reservoir, from which the patient should be allowed to inspire continuously throughout the duration of an operation, must be rejected as highly dangerous.

But, although I have thus failed to verify M. Paul Bert's precise conclusions, yet I believe we owe him a deep debt of gratitude for his researches. The experiments which I have conducted on the lines which he has laid down have made manifest an important truth entirely new to me. I had always supposed that a chloroform atmosphere sufficiently strong to produce anæsthesia would, if continued, soon lead to a fatal result. Such certainly is apt to be the case with chloroform administered by means of a folded towel. It once fell to my lot to see a patient who had been left for only a few minutes with the cloth lying over the face after full anæsthesia had been produced, in consequence of the attention of the administrator having been distracted by other matters; and I shall never forget the result. Respiratory movements had entirely ceased, and the face had a deadly pallor, and for a while it appeared as if the patient was dead, though happily revival took place after protracted artificial respiration. And I have seen other patients thrown into a condition of distinct peril from the same cause carried to a minor degree. Yet we have seen in the experiments above recorded that, even in animals which seem to have been peculiarly sensitive to the action of chloroform, atmospheres which produced anæsthesia in a very few minutes did not cause death till they had continued in action considerably more than an hour. Those atmospheres had the peculiarity of being, on the one hand, extremely mild, and, on the other hand, constant in quality: and, assuming that effects more or less closely analogous would follow in the human subject, it is clear that we ought to make a systematic attempt to attain them. If for the fitful mode of administration by the folded towel, with atmospheres perpetually oscillating between the needlessly strong and the uselessly weak, we can substitute a method which shall give a uniform and at the same time a mild anæsthetic air, we may anticipate very beneficial results. The avoidance of the needlessly strong atmospheres can hardly fail to diminish the chances of mishap from inadvertence, and this in two ways: first, by making respiratory embarrassments less likely to occur; and, secondly, by rendering it far less dangerous to continue the administration of the anæsthetic when the patient is fully under its influence. An equable exhibition of the drug will also save time, and thus not only promote the convenience of the surgeon, but also the comfort of the patient, since the after-effects of the narcotic are more or less proportioned to the length of the period during which it has continued in operation.

Moreover, the facts which M. Paul Bert has elicited may well embolden us to continue a steady administration of the chloroform after the patient has been brought fully under its influence. For we know that, when complete anæsthesia has been brought about, a very much smaller proportion of the chloroform is needed for the maintenance of that state than was required for its production: all that is necessary being to supply enough to compensate for the elimination of the drug by the lungs and other emunctory organs. Hence, if an atmosphere of the mild but constant character referred to, while effective for the rapid production of anæsthesia, may in the lower animals be continued for an hour or more of full strength without causing death, it seems only reasonable to anticipate that, if the greatly reduced proportion that suffices for maintaining anæsthesia were substituted when the patient had been fully subdued, it might be steadily continued without danger for any length of time that might be desirable. And I need hardly remark on the convenience that would result from such an arrangement, as compared with the liability to partial recovery with its attendant struggling in the middle of an operation, when chloroform is given from the folded towel by any but very experienced administrators.

But there is reason to believe that other important advantages will be gained by more uniform administration. It would appear that there are serious objections to allowing the patient to recover from time to time from the effects of the chloroform. Dr. Kirk of Glasgow made, several years ago, some interesting observations bearing on this subject, which have not yet been published, but which he kindly allows me to refer to. He found that if a cat was placed in a jar containing an anæsthetic mixture of chloroform with air, and removed when it was only partially anæsthetised, and at once examined with the stethoscope, the pulse always made a sudden and considerable rise from the depression which the chloroform occasioned, and not unfrequently this rise was followed by a complete suspension of audible cardiac pulsations, lasting it might be for an entire minute. If, however, the animal was retained in the jar till complete anæsthesia was effected, such suspension of pulsation was never observed. I am not aware that anything exactly corresponding has been observed in the human subject. But I have often seen great pallor precede vomiting under chloroform; and it seems probable that this vomiting, and the depression which accompanies it, have been due to the fitful way in which we have been in the habit of giving chloroform with the folded towel. For Dr. Kirk, who has paid great attention to this subject, informs me that he has never seen vomiting occur under chloroform except during recovery from the anæsthesia. And this experience is strikingly confirmed by Mr. Meredith, of the Samaritan Hospital, who tells me that he avoids vomiting during ovariectomy by giving chloroform with Junker's inhaler, in which air is driven by Richardson's hand-bellows through a bottle of the liquid, and thence into a vulcanite mask over the mouth and nose, where it mixes freely with pure atmospheric air inhaled through a valve in the mask. In this way the chloroform is given in a mild and very uniform manner till the patient is fully anæsthetised, and afterwards any approach to recovery is anticipated by the occasional use of the bellows. And not only is vomiting prevented during the operation, but the further highly satisfactory result is obtained that the patient is not affected to any material extent with the after-sickness which formerly proved so serious in ovariectomy, and induced Dr. Keith to abandon chloroform in favour of ether.

Vomiting under anæsthesia is a serious matter, requiring prompt attention in the way of turning the head well to one side, in order to avoid the risk of vomited matter passing into the larynx. Ether seems more liable to cause vomiting during actual anæsthesia than chloroform, and several of the deaths under ether which have been published have been from this cause. But after-sickness appears to be much more frequent and more distressing with chloroform administered by means of a folded towel than with ether; and it will be a great point gained if this serious drawback, together with the depression that attends it, can be got rid of.

Junker's inhaler acts admirably in experienced hands; but the working of the bellows is a somewhat irksome business; and there is, besides, the great disadvantage of a special apparatus which may not be always at hand, and which, if not in frequent

use, is liable to get out of order. And I cannot but think that, if the valve of the mask is not properly managed, there will be danger of the chloroform being given in too concentrated a form.

A much more simple way of giving chloroform in a continuous and equable manner is that of dropping it frequently, by means of a drop-bottle, upon a flannel bag stretched over a wire frame, as was, I believe, first suggested by the late Dr. Skinner, of Liverpool. The drop-bottle may be very simply made by providing an ordinary bottle with a second cork traversed by a piece of glass tube sufficiently small in calibre to allow only one or two minims to escape at once when the bottle is momentarily inverted. Special drop-bottles of more durable and convenient construction may be got from the instrument-makers; but for an emergency, a cork with a small notch cut out of one side, introduced into a common bottle, will answer the purpose sufficiently well. By these means chloroform may be given in a very steady, continuous manner; and some who are accustomed to this method speak very highly in its favour. But Dr. Skinner's bag is needlessly large; and from this circumstance, and also from the very accurate manner in which it applies itself to the face by means of an elastic band at its orifice, it must be apt, unless cautiously used, to accumulate too large a quantity of chloroform; and I know that deaths have occurred under its use.

A much smaller frame is also sold by the instrument-makers, with a correspondingly smaller flannel bag, fitting, like Skinner's, accurately to the face. This apparatus proved on trial amply adequate, anæsthesia being very rapidly induced, with extremely little consumption of chloroform. But, even though so much smaller, the closely fitting bag seemed to me liable to the danger of giving the chloroform too strong, especially when the breathing is shallow. I therefore made trials with a piece of flannel stretched over the small frame, but having an interval of about half an inch between its border and the skin of the face; and I found that a piece with an area of nine square inches arranged in this way, and kept constantly moist with chloroform, failed to induce anæsthesia within a reasonable time in an adult male, but answered the purpose well if a piece of rag was thrown lightly round the interval between the flannel and the skin; so as to check, but not altogether prevent, the flowing away of the heavy vapour of the chloroform. Thus I seemed to have arrived at an arrangement as near the lower limit of efficiency as was possible. And as there is no special virtue in flannel, as compared with a single layer of linen of coarse texture, I substituted for the frame and flannel the corner of a towel, pursed up systematically into a concave mask to cover the mouth and nose by pinching it together at such a distance from the corner that, when the pinched-up part is held over the root of the nose, the corner extends freely to the point of the chin.

The cap formed in this manner being so arranged upon the face, chloroform is gradually dropped upon it till the greater part of it is soaked, the edges being left dry to avoid irritation of the skin by the liquid; and the moist condition is maintained by frequent dropping until the requisite physiological effects are produced; the respiration being at the same time carefully watched with a view to the instant adoption of the measures described at page 609 in case of any obstruction to the free entrance of air. When full anæsthesia has been produced, it is steadily maintained by dropping with about half the frequency: for I find that half the quantity of chloroform per minute that is used for producing anæsthesia, is not far from the amount required for maintaining it. Any one accustomed to giving chloroform with the folded towel or compress has to learn to avoid the two extremes of applying the drop-bottle too seldom, and putting on too much chloroform at a time.

In giving chloroform in this manner, it is of great importance to bear in mind that the amount inhaled is proportioned to the surface which is moistened, so that it would not be right to use an indefinitely large piece of the towel for the purpose. When the cap is made as above directed, large enough to extend freely from the root of the nose to the point of the chin, the part which is moistened during the production of anæsthesia has an area of about nine square inches (that of a circle three and

a half inches in diameter) in the case of the adult male. But the apparatus is self-adjusting in so far that the cap varies in dimensions with the face, which again is more or less proportioned to the size of the body; and thus, for example, a very much smaller evaporating surface is provided for a young child than for an adult. It is further self-regulating in this respect, that when the breathing is shallow, and the quantity of air to be mixed with the chloroform consequently diminished, the percentage of the chloroform is not correspondingly increased, because a much smaller amount evaporates under those circumstances than when the air is moved freely over the cloth in deep inspiration; and further, when the vapour is not drawn into the chest, its density causes it to flow away under the loose margins of the cap, instead of accumulating as it would do under a closely fitting bag.

When the surface of the towel is restricted as above recommended, the proportion of chloroform to the air inhaled is extremely small. In order to estimate this proportion, it is necessary to ascertain, on the one hand, how much chloroform enters the lungs per minute, and, on the other hand, how much air is inhaled during the same period. The former element is obtained as follows:—The drop-bottle being graduated, the quantity of chloroform employed for the production of full anæsthesia is determined by inspection, and the number of minutes which have elapsed during the process is also noted. The amount of chloroform which is known to be necessary to moisten the cap being subtracted from the whole employed gives the quantity which has evaporated from both surfaces during the time of administration; and this divided by the number of minutes gives the total evaporation per minute. Then, allowing with Michael Foster that inspiration occupies about $\frac{4}{11}$ of the whole respiratory period, this fraction of the total evaporation per minute is that which was given off from both sides of the cap per minute during inspiration. But this does not all really enter the lungs: a certain quantity of the heavy vapour, particularly of that which comes from the upper surface, falls away unconsumed, and this loss cannot be considered less on the average than a third of the quantity given off from both surfaces during inspiration, so that two-thirds of that amount is approximately the quantity of chloroform inhaled per minute. In order to form an estimate of the quantity of air with which this chloroform is mixed, I have carefully ascertained, by simple means which I need not here describe, the number of cubic inches expired per minute by myself and also by a healthy woman of about the average stature, both during tranquil breathing in the recumbent posture and during the shallowest respiration which it was possible to maintain for a minute together, so shallow, indeed, as to produce serious discomfort from the *besoin de respirer*. I also tried in my own case the product of full breathing. The results were as follows:—

For myself.

Deep respiration gave	1350 cubic inches per minute.
Tranquil respiration gave	540 " "
Shallowest possible respiration gave	200 " "

For woman of about average stature.

Tranquil respiration gave	360 cubic inches per minute.
Shallowest respiration gave	235 " "

From these figures we can form a fair estimate of the amount of air taken into the lungs per minute in any given case of administration; and allowing 31 grs. for every 100 cubic inches, we calculate the percentage by weight of the chloroform to the inspired air, bearing in mind, of course, the relation of the specific gravity of chloroform to the fluid measure employed. To take two illustrations from actual practice:—A tall, middle-aged man of pretty stout build was brought into a state of full anæsthesia in 4 minutes by means of $1\frac{2}{3}$ fl. drachm of chloroform, or 138 grs.; 25 grs. would be about the quantity of chloroform remaining on a cap of the size used in his

case, and if we allow 450 cubic inches as the amount of air breathed per minute—and this is a moderate estimate—a calculation made as above indicated gives 4·9 as the percentage of chloroform by weight in the inspired air, or 1·17 by volume. Again, a woman, below the average stature and slightly built, was completely anæsthetised in $4\frac{1}{2}$ minutes by means of $1\frac{1}{4}$ fl. drachm of chloroform, or 104 grs. : and supposing that 15 grs. remained on the considerably smaller cap used in her case, and that she breathed 300 cubic inches per minute, we obtain 5·2 as the percentage of the chloroform by weight, or 1·2 by volume. The mildness of these atmospheres will be apparent when I state that M. Paul Bert's *zone maniable* was, for the dog, from 7·3 to 15·3 per cent. by weight, or 1·7 to 3·5 by volume, and for the mouse, from 4·9 to 9·8 by weight, or 1·2 to 2·33 by volume, so that the atmospheres used in the two cases referred to were considerably below the zone maniable for the dog and only just at the lower limit of that for the mouse. Or the point will perhaps appear still more strikingly when it is borne in mind that 5 per cent. by volume was that which Dr. Snow employed with his inhaler, and $3\frac{1}{2}$ per cent. by volume that which was recommended as the average atmosphere by the chloroform committee of the Medico-Chirurgical Society.¹ Even in the case of extremely shallow breathing, an atmosphere as strong as that recommended by the Committee would probably never be reached by this method. Persons less amenable to chloroform than the average yield to these mild atmospheres if they are longer continued. Thus a lady who had often taken chloroform from the folded towel or compress, and had been with some difficulty brought under its influence, was subdued in the course of 7 minutes by means of $2\frac{1}{2}$ fl. drachms, or 207·5 grs. of chloroform. She was rather a large woman, and allowing that 20 grs. were required for moistening the towel, and that she breathed 400 cubic inches of air per minute, we find by calculation that the percentage of chloroform which she inhaled was 5·3 by weight, or 1·26 by volume. On another occasion, a somewhat larger cap being employed, she was anæsthetised in 4 minutes with 2 fl. drachms, or 166 grs., of chloroform, giving a percentage of 6·4 by weight, or 1·5 by volume. These are samples of several administrations in her case, and I observed that when the milder atmospheres were used she was free from the short fit of laboured and spasmodic breathing which invariably occurred when the larger cap with its stronger atmosphere was employed. This may have been a mere coincidence, but it seemed to indicate that the milder atmosphere, though more tedious in operation, was the safer. But in cases which must be expected from time to time to arise, in which the system is unusually tolerant of chloroform, when several minutes have passed without any apparent effect being produced, there can be no objection to making the cap somewhat larger, provided the administrator bears distinctly in mind that he increases the strength of the chloroform atmosphere in proportion as he enlarges the cap.

To return for a moment to the last case mentioned, I have to add that, although she required more chloroform than the average of patients for the production of anæsthesia, yet when this had been effected, it was maintained by the steady use of a comparatively small amount. Thus on one occasion she was kept perfectly tranquil for 12 minutes during what would have been very painful procedures by the use of $2\frac{3}{4}$ fl. drachms of chloroform, giving a percentage of 3·75 by weight, or ·89 by volume, which is certainly an exceedingly mild atmosphere.

This method is a little more troublesome than our old plan of holding a folded towel over the face, and replenishing it with chloroform at considerable intervals; but the constant attention which it necessitates is an additional element of safety. During the last five months I have proceeded on these principles, and I have been much pleased with the results. The gradual manner in which the chloroform is applied in the first instance makes the administration extremely comfortable to the patient; respiratory obstruction has been markedly less frequent than formerly, even the falling back of a relaxed tongue being of rare occurrence; there has been, as a rule,

¹ Vide *Med.-Chir. Trans.* vol. xlvii. p. 353.

remarkable immunity from vomiting or after-sickness, and, except in one instance, no serious depression.

This exceptional instance deserves detailed mention on account of the illustration which it affords of an important point in the preliminary management of the patient. I operated on a delicate boy, 12 years of age, on account of the dislocation of the upper end of the radius forwards of many years' standing, removing the head of the bone and returning what remained to its natural position, an operation of short duration, and attended with scarcely any hæmorrhage. Splints having been applied to keep the bone in position, the chloroform was discontinued, when some tendency to vomiting showed itself. While in this condition he was lifted into bed, and immediately on this being done he fell into a state of collapse, which was for a short time sufficiently alarming. The explanation of this most unusual occurrence appeared to be afforded by the neglect of my orders that he should sleep the previous night at the house where the operation was to be performed at 9 A.M., and have a cup of tea, without bread, at 7 o'clock to stay the stomach; a practice which I have for many years adopted. It was only after the operation that I was informed that he had taken nothing whatever since 5 o'clock the previous afternoon, and that he had only been brought that morning to the house after a pretty long journey through London. This exertion, with prolonged fasting, combined with his weakly condition, sufficiently accounted for the symptoms of depression. While it is desirable that there should be no solid matter in the stomach when chloroform is administered, it will be found very salutary to give a cup of tea or beef-tea about two hours previously.

If chloroform carefully given in the simple manner above recommended is really as safe a means of producing prolonged anæsthesia as we possess, a conviction that such is the case will be a great relief to the majority of our practitioners throughout the country; all special apparatus being avoided, and selection of cases needless. For chloroform, if we are once satisfied of its safety, has the grand advantage that it may be used alike for the infant and the aged, and for those affected with pulmonary, cardiac, or renal disease. Wherever an anæsthetic is demanded, chloroform is applicable.

For the treatment of alarming symptoms of collapse, whether due to idiosyncrasy in the patient or to want of due watchfulness in the administrator, the practice suggested by Nélaton has proved of the greatest value. It is sometimes spoken of as 'inversion;' but all that is essential is to place the head at a considerably lower level than the body generally. Of the practical efficacy of this treatment no doubt will be entertained if we bear in mind the relief afforded in faintness by placing the patient in a horizontal position, or, if he be sitting, by depressing the head to the level of the knees; or, again, the converse fact of the occurrence of syncope on a patient sitting up for the first time after a long and weakening illness. On mere hydraulic principles, indeed, the beneficial effect of inversion would be inexplicable; seeing that gravity, being equally balanced in the arteries and veins, cannot of itself promote the flow through the blood-vessels, except in so far as the increased pressure due to that cause might lead to their distension and so to diminution of friction; while in the special case of the brain the enlargement of the vessels as a whole would be effectually prevented by the circumstance of the organ being enclosed in an unyielding box. But we know, from observations which I have published elsewhere,¹ that when any part of the body is raised, its arteries, large and small, are thrown into a state of contraction through the vaso-motor nervous system; and conversely, when a part is placed low, its arteries become freely relaxed through the intervention of the same nervous agency, out of all proportion to any effect which the increased pressure of the blood upon their walls through gravity could occasion. We therefore understand how 'anæmia of the brain,' or languid flow through constricted arteries, may be caused by

¹ See an address on the Influence of Position on the Local Circulation, *Brit. Med. Journ.* June 21, 1879.

unwonted elevation of the head, and how relaxation of the cerebral arteries, and correspondingly free flow of blood through them, may be induced by placing the head unusually low.

I have myself seen some striking examples of the advantage of acting on Nélaton's suggestion.

I once operated for fissure of the anus on a lady above middle life, who was so exceedingly liable to fainting fits that two medical friends of hers who were present had great dread of her taking chloroform. For my part, I believed that if she was to be operated on at all, chloroform would prove advantageous by protecting her heart from shock. It was accordingly administered, and she took it perfectly well; but before she was fully under its influence I yielded to the entreaties of my colleagues, and against my own judgment proceeded to the operation. As the knife passed through the sensitive part she ceased to breathe, and became deadly pale. I instantly turned her round across the bed, so that her head and shoulders hung over its side, and performed artificial respiration by Sylvester's method. In a short time natural breathing recurred; and when it had continued for a while, I replaced her in the horizontal position. No sooner was this done than the alarming symptoms returned; but they were again dispelled by a repetition of the same treatment. This time I took care to keep the head dependent for a considerably longer period, and the result was permanent recovery. In that case my belief was that a more complete action of the chloroform would have obviated the collapse.

In another case no such explanation of the syncope was possible.

I had performed a trifling operation upon the arm of a delicate little girl under chloroform in King's College Hospital. Nothing unusual had occurred, and she was sent off on a wheeled couch to the ward, about thirty yards distant. Whether she was made to sit up as she was lifted into bed (a thing which ought never to be done) I do not know; but she had hardly been placed there when she fell into a state of collapse, and I was at once summoned. Running to the ward, I found her face blanched, and respiratory movements entirely absent. I immediately did as in the former case. No sooner was her head placed dependent than a rosy colour suffused the white cheeks; and after a short time of artificial respiration by Sylvester's method, she was breathing naturally.

I have had occasion to refer more than once to Sylvester's method of artificial respiration. In it inspiration is effected by drawing up the arms above the head till they are in a line with the trunk, and thus raising the ribs through the medium of the muscles which connect them with the upper extremities; while expiration is produced by lowering the arms and pressing the elbows firmly against the front and sides of the chest. I can testify to the great superiority of this method over the old plan of merely compressing the thorax intermittently, and trusting to its expansile elasticity for inspiration.

Inhalation of the vapour of a few drops of nitrite of amyl as a cardiac stimulant is stated to have proved useful in some cases of collapse under chloroform. And in accordance with the exaggerated idea of the sedative influence of chloroform upon the heart to which I have above referred, the admixture of a small quantity of the nitrite of amyl with it has been suggested as a preventive of cardiac depression. The proposal has not, however, met with acceptance; nor is it likely to do so, seeing that the nitrite, while a very potent agent, seems to be inconstant in its operation.

The same dread of the depressing effect of chloroform upon the heart has led some surgeons to use it mixed with ether, together with some alcohol to produce complete blending of the two liquids. Deaths have, however, occurred under the use of such mixtures, and we have no evidence that they are really safer than undiluted chloroform carefully given.

The hypodermic injection of morphia a short time before chloroform is administered has been recommended in Germany for some special operations, on account of the remarkable result, which certainly follows such practice, that the patient may be deprived of sensibility to pain, though still retaining consciousness and voluntary motion; so that he is able to assist the surgeon by his own exertions. I understand, however, that a very serious depressing influence upon the nervous system has been sometimes found to result from this combination of the two narcotics.

A favourite method with some London practitioners is to begin by giving nitrous

oxide, and when anæsthesia has been rapidly produced in this way, maintain it by means of ether. The patient is thus saved the discomfort of the inhalation of ether, and I am not aware that any disadvantage attends the preliminary use of the nitrous oxide, except the inconvenience of the necessary apparatus, which practically must restrict this mode of procedure to dentists and persons who devote themselves specially to the administration of anæsthetics.

Ethidene dichloride, or ethidene, as it is often called for the sake of brevity, was recommended, as we have seen, by the Committee of the British Medical Association. It happens, however, that in the trials which it has received on the human subject, fatal results have been proportionally more frequent than with chloroform.

Bichloride of methylene, administered by means of Junker's inhaler, has proved itself an excellent anæsthetic. We have, however, no proof of its superiority over chloroform, either in safety of administration or immunity from subsequent inconvenience. And it has the disadvantage compared with chloroform, that it is an unstable compound when kept in contact with the air.

JOSEPH LISTER.

MINOR SURGERY.

THE following essay is not intended to embrace all matters usually included under the term 'Minor Surgery,' since many of these will be found scattered through this work, being treated of under the special diseases or particular localities with which they are more immediately connected. Nor does it attempt to enter into the minute details found in systematic works on minor surgery; but its aim is to describe briefly such proceedings in that branch of surgery as are for the most part general in their application to the several regions of the body, and are used in the treatment of many and various diseases.

INSTRUMENTS.

It is not my purpose to enter into any general description of surgical instruments, but rather to indicate those which the surgeon should always have at hand to meet the exigencies and execute the operations of minor surgical practice. These are usually arrayed in a compact and portable manner in the convenient form of a pocket-case, which should be as light as possible and contain the following—a scalpel and straight bistoury in a single handle, two curved bistouries (one blunt-pointed) similarly set, a straight and a curved abscess-knife, a pair of scissors, a pair of dressing-forceps, a pair of artery-forceps, a spatula, director, probes, caustic case, female catheter, lancets, a trocar and cannula, suture needles and silk. All the knives, it need scarcely be mentioned, should be spring-backed. The scalpel may be used for opening abscesses, for making incisions through the superficial parts, and for the purposes of dissection, as in the removal of small tumours; whilst the long, narrow, straight, sharp-pointed bistoury is better adapted for the minor amputations of fingers and toes. The curved bistouries are required generally for slitting up unhealthy sinuses proceeding from badly-managed suppurating buboes, for dividing the contracted prepuce in sloughing ulcers of the glans penis, for laying open a fistula in ano, &c.

Two special abscess-knives, fitted in a single handle, one straight (Paget's), the other curved or sickle-shaped (Syme's), are convenient instruments. The blades are small, narrow, extremely sharp, finely pointed, and not very thin, and they serve the purpose of making either a small, almost exploratory, puncture, or a long deep evacuating incision.

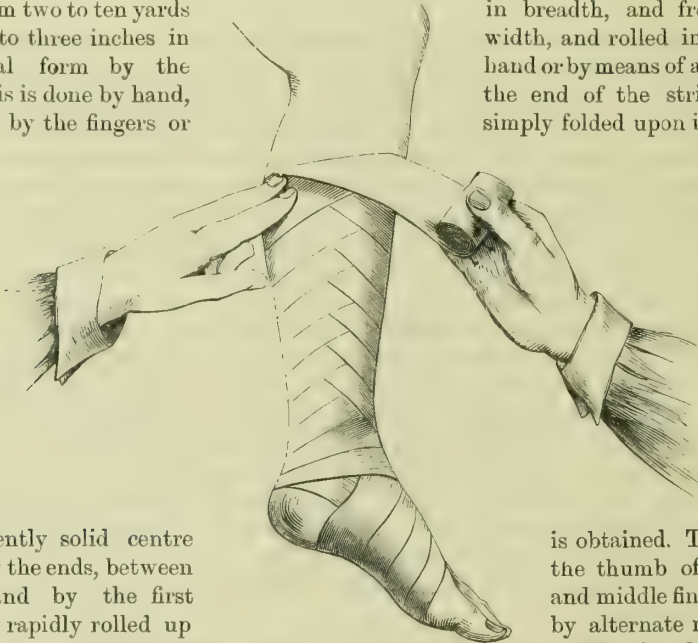
The scissors should cut well to the point. Some surgeons carry two pairs—one for plasters, the other for operations. Those for the former purpose may be made with the blades bent at an angle. A strong pair of dissecting-forceps are absolutely necessary, and the dressing-forceps should be made much stronger than the common ones, inasmuch as they are required for the removal of pieces of dead bone, or for grasping foreign bodies, when the exercise of considerable force is necessary. Of the many varieties of artery-forceps, the ordinary fenestrated hooked forceps, fitted with a catch removable at pleasure, is best suited for the purposes of the surgeon, and, if there be sufficient room in the case, a pair of torsion-forceps will be found serviceable. Bleeding-lancets are now but rarely required for the purpose of venesection, but are useful for vaccination and for opening boils and very small abscesses, &c. The director, made of silver, has the handle-end either flat and sometimes fissured or fashioned into a scoop, and the other extremity rounded off, or prolonged into a probe point. The fissure was used by the older surgeons to protect the ranine artery in division of the frænum linguæ. A flat steel director, as invented by Mr. Wormald, is a useful instrument in the division of very tight strictures, such as that of Gimbernat's ligament in femoral hernia, and may be added to the case.

Probes are usually made of silver—the reverse-end of one being sharp, that of the other having an eye; but a steel probe is a useful instrument; it is firmer when used for the examination of carious bone, or for the search after foreign bodies. The caustic case should be of silver, and fitted at the other end with a grooved exploring needle; in addition to the latter, a trocar and cannula in an ivory case will be found handy. A tenaculum and gum-lancet may also be carried, and in a side pocket ligature silk (of which there should be two or three sizes), hempen ligatures, and needles.

BANDAGES, AND THEIR APPLICATION.

Bandages are appliances adapted, according to circumstances, to maintain uniform pressure on subjacent parts, to retain in position fractured or dislocated limbs, to assist in maintaining contact between the edges of large wounds, or to aid in the application of topical remedies to various parts of the body. For ordinary purposes they are made of linen or stances, muslin, linen, elastic material, as webbing have been employed. The strips from two to ten yards quarters to three inches in cylindrical form by the When this is done by hand, rolled up by the fingers or

FIG. 114.



a sufficiently solid centre firmly by the ends, between below and by the first and then rapidly rolled up of pronation and supination the bandage is held,

portion is passed through and kept back by the thumb and forefinger of the other hand. Thus prepared for use, each roller possesses two extremities, two surfaces, and a body, and is *single-headed* when rolled up from one end alone, the other remaining free, or *double-headed* when both ends are rolled up into a separate coil towards the centre.

The more useful forms of bandage may, however, be included in two groups: (1) the simple or continuous; (2) the compound bandages. Under the term 'simple' may be included those in which a continuous roller is employed; these are the circular, oblique, spiral, reversed, figure-of-eight, and scalp bandage. Compound bandages are such as require more than a continuous roller for their proper adjustment; these may be enumerated as the many tailed, the four-tailed, the suspensory, and the T-bandage, besides others which will not here be referred to, as their preparation and application belong to the province of the instrument-maker or bandagist.

The simplest of all bandages is the circular, each turn of which accurately crosses the preceding ones as employed for the forehead or neck; but when a considerable

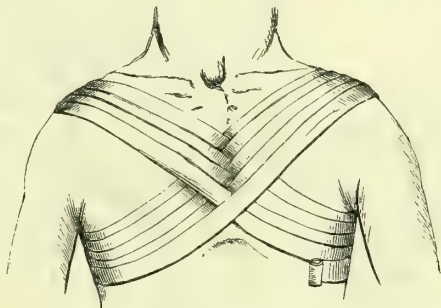
calico; but in particular ingauze, flannel, domett, or some or vulcanised india-rubber, material is cut or torn into in breadth, and from three-width, and rolled into a tight hand or by means of a machine. the end of the strip is first simply folded upon itself until

is obtained. This is held the thumb of one hand and middle fingers above, by alternate movements of the hand in which whilst the unwound portion

portion of a limb or the trunk require to be covered, the oblique or the spiral is necessary. The latter consists of the spiral application of the roller in such a manner that each succeeding fold overlaps the preceding by about one-third of its width; and is used for the fingers, toes, thorax, abdomen, and the extremities; but if the circumference of the part to be bandaged be not of uniform calibre, but increase gradually from below upwards, the reversed must be substituted for the spiral in these positions in order that the bandage may lie evenly and exercise a uniform compression. This proceeding is represented in fig. 114, and must be performed at each turn of the roller exactly at a corresponding point on the outer surface of the limb, and is accomplished by fixing the upper end of the bandage with the forefinger of one hand, whilst the roller, held slackly and not too much unrolled, is turned downwards and reversed by a movement of pronation of the opposite hand. The spiral is not well suited for passing smoothly over the angles of flexion and extension of joints such as the ankle, knee, elbow, shoulder, thumb, &c., for which purpose the figure-of-eight is better employed. This bandage consists of a spiral, the turns of which are carried alternately upwards and downwards so as to cross each other in front. At the ankle the crossing of the bandages is so arranged as to fall in front of the joint, whilst the two circles of the figure embrace respectively the leg and foot (fig. 114). The knee is covered in in a similar manner by fixing the bandage with a circular turn below the joint, carrying it upwards in front of the patella to the thigh, which it is made to surround circularly, and then bringing it down across the ascending limb, repeating these turns in an overlapping manner until the whole surface of the knee is concealed. At the elbow this form of bandage embraces the arm and forearm, and, crossing over the flexure of the joint, may be made available for compressing the orifice of the vein after venesection (fig. 116 F). In applying it to the

thumb, one limb of the figure should surround the root whilst the other passes round the wrist, the crossing of the bandage being situated on the subcutaneous margin of the metacarpal bone (fig. 116 E). The figure-of-eight bandage is adapted to the chest so as to cross in front of the sternum and draw the shoulders forwards, or behind over the dorsal spine so as to draw the shoulders backwards. In the anterior figure-of-eight, the bandage is commenced behind one shoulder, over which it is carried downwards and forwards across the front of the chest to the opposite axilla, passed under this up and over the same shoulder, and then downwards, crossing the first in front of the sternum to the first axilla. This is repeated with overlapping turns until the bandage is complete (fig. 115). The same form of bandage may be made available for compressing or supporting one or both breasts by being passed round the thorax under the affected breast and over the opposite shoulder. The posterior figure-of-eight is somewhat similar in its application, but is commenced in front of the shoulder and carried downwards across the back behind to the opposite axilla. At the groin a form of figure-of-eight, under the name of *spica*, is employed for retaining dressings and compresses in the situation of the abdominal and femoral rings, as after the operation for strangulated hernia. It is either single or double, according as either one or both groins require bandaging. For the single *spica* a roller of eight to ten yards' length is required. It is fixed by two or three circular turns round the upper part of the thigh, then carried obliquely upwards in front of the groin to between the great trochanter and the crest of the ilium, round the pelvis to the opposite side, down in front of the pubes, crossing the first oblique turn at the centre of the groin to the outer side of the thigh below the trochanter, and then behind the thigh upwards to the groin (fig. 116 D). A roller of twelve yards is necessary for the double *spica*. Having been fixed by two or three turns round the

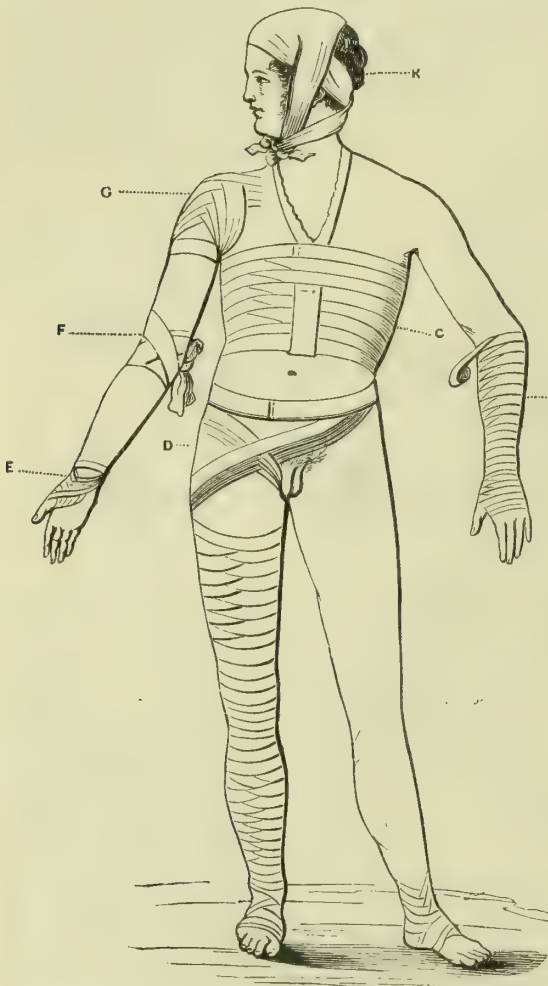
FIG. 115.



pelvis, the roller is brought down obliquely across the left groin, round the back of the thigh, and up on the inner side to the groin; then round the pelvis behind to the right groin, downwards on the inside of the right thigh, behind it and up again on its outer side to the joint, separating these turns so far as they are necessary. A similar spica bandage serves to cover the shoulder, the roller being passed round the upper part of the chest under the opposite axilla, and crossed over the prominence of the head of the humerus (fig. 116 c).

These different varieties of bandage are employed in conjunction with each other in the extremities in which the circumference of the limb varies at different parts and

FIG. 116.



irregularities of surface exist.

To bandage the whole lower extremity, the body of the roller is held in the right hand and its free end in the left, the outer surface of the latter laid upon the dorsum of the foot and fixed by a circular turn. Passing over the limb from the inner to the outer side, the enlargement of the instep is covered by a succession of reverses; on the ankle-joint it is applied as a figure-of-eight, at the lower part of the leg with simple spirals, and the upper part with reverses; the knee-joint is bandaged with the figure-of-eight, the thigh with spirals and reverses according to the varying conformation of the part, and, in completion, the groin with the spica. It may be fastened off by pinning its end to the last fold applied; or the end may be split into two, and these, being carried in opposite directions around the limb, may be tied together where they meet.

The peculiar shape of the thorax, increasing as it does in circumference from below upwards, requires that a roller applied to that part, commencing from below,

should be turned on itself as it ascends. Before applying a bandage to the thorax, a wide piece of roller about five feet in length should be split lengthways from its centre for about half a yard; this being thrown over the head of the patient, the ends may be allowed to hang down in front and behind. The patient, standing with his back towards the surgeon, his hands raised above his head, and resting against some support, the bandage may be applied over the neck-piece, beginning from below. It may be finally fastened off and secured from slipping in the manner represented in fig. 116 c.

Of *scalp bandages* there are two special varieties, the knotted and the recurrent; they are employed for retaining local applications to wounds of the scalp, or for

exercising pressure on the part to control hæmorrhage. The knotted bandage, which is generally employed for compressing the temporal artery, is applied in the following manner. A bandage, about two inches in width and four yards in length, being rolled up at either end into two separate and unequal portions, the surgeon taking one head of the roller in each hand, and standing facing the wounded artery, applies the unwound portion of the bandage over the compress. He should now pass his hands around the head, one on either side, so as to encircle it with the roller until he reaches the opposite temple, when the two heads of the bandage being crossed, they may be brought back again to the point of departure. Here, being crossed one over the other, their direction should be changed, one end being carried under the chin, the other over the vertex, so that they may again meet over the opposite temple, where they are again to be crossed and carried around the head, one on either side, to the point whence they first started. Here, again, they are crossed, carried respectively under the chin and over the vertex, and so on until sufficient compression is exercised over the wounded vessel. The application may be secured in position by a few circular turns of the long end of the roller (fig. 117).

FIG. 117.



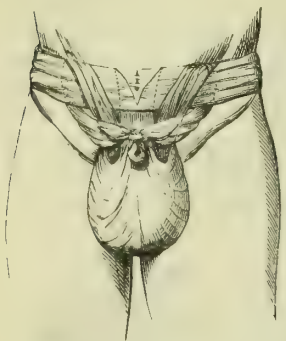
The *recurrent* or *capelline* bandage is applied in the following manner:—The outer surface of the central portion of a double-headed roller, two inches wide by twelve yards long, is placed low down over the centre of the forehead, and its two bodies carried backwards to below the occipital protuberance where they are crossed; the one is brought forward in the central line over the vertex to the forehead, where it is fixed by the other, which is continued circularly round the head; then backwards again on one side of the central turn, and, overlapping it, to the occiput, where it is again fixed by the circular turn; again forwards, to the forehead on the other side of the central turn lying on the vertex; and these overlapping turns are thus repeated alternately on each side of the head, and with the circular turns, until the whole of the scalp is covered in completely.

Compound bandages.—The single T, the double T, the four-tailed, the many-tailed, and the suspensory bandage fall under this denomination. The T-bandage is formed of two pieces of linen roller attached to each other in the manner indicated by the name of the application. It is principally used in the neighbourhood of the perinæum, where it is well adapted to maintain pressure on the parts, or to retain in position any topical application. In applying the bandage, that part of it represented by the horizontal limb of the T being passed around the body just above the crests of the ilia, should be fixed by tying together the ends in front of the belly, in such a position that the vertical part of the bandage shall be situated over the spines of the lumbar vertebræ; if the application is to be adjusted to a female, the loose end may now be brought forward between the nates and in front of the vulva, and attached to the horizontal portion in the median line of the abdomen. If the patient is of the opposite sex, the vertical part of the bandage should be split at its free end, and the two ends brought up one on either side the scrotum and penis to be attached to the part of the bandage that encircles the body.

The *double-T* has two vertical strips, about two inches apart, stitched separately to the horizontal portion, and is adapted for securing and keeping in position dressings in different parts of the body. When applied to the head, the centre of the horizontal strip is placed upon the forehead, and its ends conducted backwards so as to cross the vertical strips which have been carried backwards over the vertex; both are then returned to the forehead and fixed there. For retaining applications after amputation of the breast, the horizontal part, which should be of the necessary breadth, is carried round the chest below the axilla, and the vertical strips brought forward over each shoulder and secured to the former, in front. In regions such as the groin or buttock, a triangular piece of calico or linen should be inserted between the horizontal and vertical divisions, its base being secured to the former, and its apex to the latter; this is

placed in front of the groin with the base upwards; the horizontal limb is passed round the abdomen and tied, and the vertical secured by circular turns round the thigh.

FIG. 118.



Suspensory bandages are to be procured ready for use of an instrument-maker, though occasionally they must be improvised by the surgeon; for such an emergency, a handkerchief or a piece of bandage being tied around the abdomen just above the crest of the ilia, a second handkerchief should be passed beneath the scrotum, and attached in the manner represented in fig. 118.

The *four-tailed bandage* is made by taking a piece of linen about six inches wide and a yard and a-half long, and splitting it up the middle from either end to within three or four inches of the centre; this would form such a bandage as might be applied over the knee; but of course the size of the apparatus must be regulated by that of the part of the body to which it is to be adapted. The form of bandage under consideration is generally employed for maintaining in position topical applications, but is occasionally made use of to secure the correct apposition of fractures; it is applied over the knee-joint, to the lower jaw, and on the vertex. To adjust this bandage to the knee-joint, the centre of it should be placed on the patella, the four tails, being passed around and under the knee and crossed behind the limb,

FIG. 119.



should be brought forward again, the lower pair being tied together in front of the thigh above the patella, the upper pair over the head of the tibia on the anterior aspect of the leg. For the lower jaw the bandage should not be more than three or four inches in width, and a hole should be cut in its centre to admit the prominence of the chin; in adjusting it, the centre of the bandage should be placed under the chin, and the tails being carried upwards, the hindmost pair should be tied over the vertex about the situation of the coronal suture, while the anterior pair of ends are taken backwards and fastened together above the occipital protuberance. When applied to the vertex, the bandage should be wider than that required for the chin; its centre being placed on the vault of the skull, the posterior tails should be brought down and tied together beneath the chin, while the anterior pair are carried backwards and fastened beneath the occiput, or brought round again under the chin (fig. 116, κ).

The *many-tailed bandage*.—The advantage of this form of application is, that it can be applied and removed without any disturbance of the parts to which it is adjusted; and thus it is chiefly used in the treatment of compound fractures, in the

FIG. 120.



dressing of stumps after amputation, or in any case where absolute quietude is desirable. The bandage is constructed in the following manner: to a wide piece of roller, rather longer than the part of the limb to which the bandage is to be applied, should be stitched in succession several shorter portions of a narrower bandage; these should be attached by their centres in such a manner that each piece is at right angles to the long roller, and overlaps the preceding piece by one-third of its width. These shorter portions should be each about half as long again as the circumference of the limb they are to surround. This bandage, like the spiral, should be applied from below upwards; the back piece should be drawn up behind the limb or part which is to be bandaged, and the transverse portions spread out evenly on either side, the last piece sewn on standing first in order for application. Beginning from below, the opposite ends of these transverse pieces should be crossed over each other around the limb, each succeeding pair

overlapping and keeping in place the ends of bandage that immediately preceded them (fig. 120); the last pair may be tied together, or kept in position with a pin.

In 1838 M. Mayor devised a system of bandaging by means of the handkerchief in place of the ordinary roller, and claimed for it numerous advantages, viz. that its application was more easy, that it was less liable to relax or become deranged, that it required no preliminary preparation, and that it was more easily changed and reapplied. The handkerchief serves as the basis of this system, and is employed in four different modifications: the square, which folded upon itself becomes the oblong; the triangle, by folding the square diagonally; the cravat by folding, and the cord by twisting, the triangle upon itself. A few examples of the special application of these to the different regions of the body will suffice to explain the use of the method.

The *fronto-occipital triangle*, for retaining dressings on the head.—The base of the triangular handkerchief is placed over the forehead, and its apex allowed to hang down behind; the ends of the triangle are carried backwards, crossed below the occiput and pinned to its sides, whilst the apex is turned over and pinned to the handkerchief above. According to the necessities of the case, the position of the handkerchief may be modified by placing its base posteriorly below the occiput, or laterally over the temporal region.

Mammary triangle, for retaining dressings on the breast.—The base of the triangle is placed immediately beneath the organ, and its apex over the same shoulder; the ends are carried over the opposite shoulder and tied under the axilla, and the apex is finally pinned to the handkerchief behind.

Dorso-sternal triangle.—One handkerchief is first tied round the body below the axilla as a cravat, the base of the triangle placed upon the nucha, and its two ends brought in front of the sternum, are tied to the cravat in front, and the apex to the same behind.

Gluteal triangle.—A cravat is tied round the body above the crest of the ilia, the triangle is placed with its base below the gluteal fold, its ends tied round the thigh, and the apex passed underneath the cravat above, turned back and pinned.

The cravat is adapted for the axilla and the groin.

The *bi-axillary cravat*.—Its centre is placed in one axilla, and its ends crossed over the shoulder and carried, one in front, and the other behind, to the opposite axilla, where they are tied.

Dorso-biaxillary cravat, for drawing the shoulders backwards.—Two cravats are thus arranged: one is tied in a loose ring round one axilla and shoulder and knotted behind; the body of the other is placed in front of the opposite shoulder, its ends brought one over the shoulder and one under the axilla, tied behind in a single knot, and then passed through the ring of the first cravat, and the knot completed to the requisite tightness.

For a *spica* of the groin the broad centre of a cravat is placed obliquely across the affected part of the groin, and the inner end carried round the inner and posterior surfaces of the thigh to the front, and the outer round the ilium and body to the front, where they are both tied together over or pinned to the central part of the cravat in the groin.

IMMOVABLE APPARATUS.

Under this head it is proposed to consider those methods of bandaging by which support and immobility are secured; the essential principle of the application being that it admits of adaptation while in a moist and pliant condition, and is thus enabled the more exactly to accommodate itself to the conformation of the parts to which it is applied, before assuming its permanent condition of immobility.

The various substances which have been employed are, gum and chalk, white of egg and flour, starch, plaster of Paris, gum, dextrin, glue, silica, cement, paraffin, gutta-percha, millboard, pasteboard, leather, poroplastic felt. They serve to fix the limb or other part of the body in position, in recent or ununited fractures, for the purpose of rest and immobility in disease of joints, after operations, excisions, &c., and for the rectification of deformities and curvatures of the body.

Gum and chalk is prepared by rubbing together in a mortar mucilage with a sufficient amount of chalk to form a mixture about the consistence of thick cream.

The limb being placed in the position in which it is desirable it should be retained, should be protected over its more prominent points with a layer of cotton-wool. Having been firmly and evenly bandaged, the gum and chalk may be smeared over the roller with a brush or the open palm of the hand; or the bandages, having been re-rolled in the gum and chalk mixture, are applied in a moist state. The number of bandages will depend upon the degree of rigidity which is desired. Two are sufficient for ordinary purposes; but the apparatus may be further strengthened by combining with it splints of pasteboard or millboard. After these have been cut or torn to the requisite shape and size, they are rendered pliant and soft by soaking in hot water, then dipped in the mixture of gum and chalk, and applied either immediately outside the protective layer of cotton-wool or between the first and second layer of bandage.

Starch, white of egg, and dextrine are all used in their fluid forms as stiffening materials for bandages. The roller may be soaked in a solution of one or the other of these substances previous to its application; or again, the roller being cut into short pieces, each half as long again as the circumference of the limb, these portions may be applied separately to the part from below upwards; the opposite ends of each piece crossing one another, over the anterior aspect of the limb, and each succeeding piece overlapping the one that went before it by one-third of its width. The gum and starch bandage takes from four to five hours to dry, and during this time, if there is any considerable tendency to displacement in the limb, means must be used to counteract it until the application has become rigid. For this reason it is that the plaster of Paris, or gypsum bandage, as it is called, is preferred by many to the gum and starch.

Plaster of Paris or gypsum.—The requisite materials for the application of this bandage are: the plaster of Paris, warm water, gauze bandage, cotton-wool or a flannel roller. The plaster of Paris, which must be freshly prepared, is first thoroughly incorporated in the meshes of the gauze or crinoline bandages during the rolling of these, by the hand or by the spatula, or by some form of roller-machine invented for the purpose. These meshes should be sufficiently large to retain the dry plaster, but not so capacious as to permit this to fall through. Thus prepared, the bandages may be either used immediately or preserved in a receptacle with a tightly-fitting cover to exclude the air, until required. After the limb has been protected, especially over the points of pressure, by a thin layer of cotton-wool or a flannel bandage, a plaster roller is placed in the basin of warm water for two or three minutes until it is thoroughly wetted, and so long as air bubbles continue to escape from it. It is then removed, squeezed firmly to expel the excess of moisture, and applied to the part in the ordinary manner by simple circular turns without any reverses. A second bandage is placed in the water during the application of the first, so as to be ready when required; and three or four are put on in a similar manner until the requisite immobility is attained, a result which varies according to the quality of the gypsum and its thorough incorporation with the bandage. Should the latter be insufficiently wetted, it may be moistened by the hand of the surgeon, as it is being rolled round the limb, and to give the splint a more finished appearance and greater strength, the outer bandage may be smeared over with a thin layer of plaster cream. Greater rigidity may also be secured by inserting thin, flexible chips of wood between the layers of bandage. It hardens by the setting of the plaster in from ten to fifteen minutes. When the splint requires to be divided or opened up, this is best undertaken about two hours after its application, when it cuts firmly but without excessive difficulty, and interruptions or windows for the escape of discharges or for the use of local remedies may be made at the same time, their exact position having been noted before the application of the bandage, or indicated by an additional thickness of cotton-wool. In order to protect the splint when it is exposed to the action of moisture, its surface may be varnished, or rendered impermeable by brushing it with a solution of shellac in alcohol, or dammar in ether, until the outer layers are saturated, or by coating it externally with a layer of cement. Its great hardness renders its subsequent removal a matter of some little difficulty, and affords, together with its great weight, the chief objections to its employment. It is accomplished by

dividing it with a strong knife, with the plaster scissors, or with the saw; or by previously dissolving the plaster along the line of section by the use of nitro-hydrochloric acid, or by soaking and softening the plaster by a solution of ordinary salt or bicarbonate of soda.

Glue furnishes a light, firm, and elastic immovable bandage suitable for certain purposes. The best French glue is first soaked in cold water for some hours, and then melted in the usual way. One-fifth of its bulk of alcohol is added, and the two stirred till liquefied, the addition of the alcohol serving to accelerate the subsequent drying and hardening of the bandage. The foot from the toes to the ankles is bandaged, and the leg from the ankle to the knee wrapped in cotton-wool. A cotton bandage is applied over all and brushed over with the liquid glue, a second and third are put on in the same manner, and the whole left for twelve or twenty-four hours, when it is cut through its whole length, the edges separated sufficiently to strip it from the leg, and the splint fitted if necessary with eyelets and a lace. In order to furnish additional strength to the splint, strips of linen soaked in glue may be used.

Silica, or liquid glass, a solution of the silicate of potash or soda, possesses the advantage of being always ready for use, of requiring no previous preparation, and being cleanly and agreeable in manipulation. The limb is encased in cotton-wool, the bandages are rolled up in a basin containing the liquid glass, and then applied in several layers, or they may be put on dry and painted over with the silica by a brush. It remains soft and flabby for some hours; and continues to harden for two or three days. It does not contract on drying, and if a greater degree of hardness is required, whitening, chalk, or plaster may be mixed with the silica, or additional strips of linen bandage or paper may be employed. Its removal is effected in a few minutes by moistening the splint.

Paraffin forms a light, easy, and comfortable splint for many purposes, is easily applied, and readily cut with a knife. It forms a white inodorous substance, melting at a temperature of 130°, and should be used perfectly pure. Having been liquefied in a vessel containing boiling water, the substance selected to enclose the limb is soaked and saturated with this. The limb, being enveloped in a soft cotton bandage, is covered with strips of coarse flannel bandage dipped in the molten paraffin, and after setting has taken place, the whole is coated with the paraffin sufficiently cooled to become viscid, so as to produce an even surface. The application of linen compresses steeped in cold water to the surface of the splint solidifies the paraffin. McEwen states that cotton-wool in a single sheet answers best as an absorbent and adaptable material for the paraffin. This is wound round the limb, trimmed with the scissors, removed, rolled up, and submerged in the liquid paraffin for two minutes. It is then taken out, unfolded on a piece of macintosh until sufficiently cooled to be touched without inconvenience with the back of the hand. A gauze roller is first applied, over this the cotton-wool splint, and finally a second external roller, so as to compress the cotton-wool with some firmness. If plunged in cold water, or wetted on its outer surface, the paraffin hardens rapidly. Paraffin has the advantage of being re-obtained from the old splint by soaking it in boiling water, and removing the paraffin, as it forms a cake on the surface during cooling.

Gutta-percha is softened after it has been cut to the proper shape, by immersion in boiling water; when it has become sufficiently pliant, it is cooled by plunging it momentarily in cold water, and is then carefully moulded to the part, and accurately bandaged in this position until it has become firm. It is then removed, trimmed, and, if necessary, lined with chamois leather. Millboard and pasteboard are quickly prepared for use by soaking for a short time in warm water. Splints from leather are more serviceable where more perfect fixation and immobility are required. A shape is first cut from paper, which, after being carefully fitted to the limb, is laid upon a sheet of sole leather, and a corresponding piece cut from the leather. This is softened by soaking it for twenty-four hours in cold water, or for a shorter period in warm water with the addition of vinegar, and when thoroughly soaked, is fitted and moulded to the outlines of the limb by the hands. As soon as it is accurately fitted, it is bandaged firmly in position until in twelve or twenty-four hours it has become

again rigid ; when it is removed, trimmed, lined with chamois leather, and fitted with eyelets so as to lace up.

Poroplastic felt has of late been extensively used for the purposes of splints and spinal supports. This felted substance, which is stiffened by special preparation with various gums, is hard and rigid when cold, softens under the influence of heat, when it is capable of being moulded to any shape, and may be remoulded any number of times. Simple splints may be cut as required from the sheet ; but more complicated apparatus, such as spinal jackets, must be moulded beforehand on blocks of different shapes or sizes. The jacket, thus fastened, is first softened in boiling water, or, what is preferable, in a hot-air chamber at a temperature of 200°, then rapidly removed, transferred to the part of the body for which it is intended, and having been buckled tightly, so as to retain its position, is worked into an accurate fit by the hands, whilst it is soft and pliant.

One great advantage attaching to the form of apparatus under consideration is the manner in which it may be adapted to changes in the size of the limb. When, from swelling of the parts beneath, it is necessary to loosen the bandage, the whole application should be cut from end to end with strong scissors or a knife, on the anterior aspect of the limb ; this will entirely relax the parts. Subsequently the degree of support and pressure to be exercised may be regulated by passing straps and buckles around the case in which the limb now lies, and tightening or loosening these as occasion may require.

Where, from subsidence of swelling or other causes, it becomes necessary to tighten the application, a longitudinal strip may be cut out of the apparatus from end to end, and with straps and buckles the sides of the case may be brought more nearly into apposition.

SUTURES AND THEIR APPLICATION.

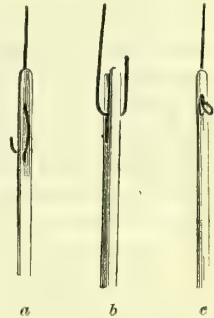
Sutures are used for bringing together and maintaining in contact the opposed surfaces of wounds. They differ both in the method of their application and the material of which they are composed : this difference is owing to the varying necessities of wounds, as these vary in character, or occur in one or another part of the body. There are four principal varieties in the method of applying sutures : (1) the continuous ; (2) the interrupted ; (3) the twisted ; (4) the quilled. Silk is the material most extensively employed for the purpose of sutures ; but the necessity of its early removal, and the irritation which its presence not unfrequently excites, have led to the introduction of other substances. Metallic sutures of iron and silver formerly met with considerable favour, but, although non-irritating, they are prone to cut their way out, and to give pain in their removal, and are consequently much less in vogue than hitherto. Catgut is absolutely non-irritating and antiseptic, but softens too quickly for the rôle of sutures in wounds which require support for long periods ; the chromicised gut is, however, more satisfactory in this respect, being stronger and capable of resisting absorption for a longer period. Among other materials whose strength and unirritating properties render them peculiarly suitable for sutures, are horsehair, silkworm gut, and tendon.

To save subsequent repetition, certain general principles applicable to all forms of suture will be noticed. In passing the needle, the edges of the wound may be advantageously held in contact with the forefinger and thumb of the left hand, or they may be simultaneously tightened so as to bring them parallel to each other, that their opposite and corresponding parts may exactly coincide. The needle should penetrate the surface at an angle of 50°, and should at least pass through the whole thickness of the integument at each stitch ; as a general rule, the thread should penetrate to a sufficient depth to avoid leaving beneath it in the wound any considerable cavity or space in which pus can accumulate. The distance from the edge of the wound at which the suture should enter and leave the part must necessarily vary with the depth of the wound and the amount of tension to which the thread will be subject, but in no case should there be less than the eighth of an inch between the

suture-hole and the margin of the wound. Sutures, as a rule, ought not to include vessels, nerves, fasciæ, muscles, or tendons. Where more than one suture is used, the interval between the points of suture in the wound should be sufficiently small to overcome any tendency there may be for the edges of the wound to evert, or the fat and subcutaneous tissue to bulge. The line of the thread ought to cross that of the wound at right angles; and in cases where the thread has to be tied, care should be taken that the knot may fall on one side of the line of contact of the edges of the wound. A single knot having been tied, some precaution should be taken to prevent it slipping while the second knot is prepared. This may be tied firmly, but need not be tightened by the exercise of any force. The needles for carrying the sutures are either straight or curved. The former are of various sizes, with either triangular or spear-shaped points, are easier and more preferable to use, and are especially employed for the free margins of extensive wounds, such as are left after amputation or the removal of large tumours. The latter, either crescentic or half-curved, are more difficult to introduce, and best suited for wounds the edges of which can be transfixed by a single plunge, or which occur on irregular surfaces as the face, or are deeply situated in the cavities and canals of the body. The curved needle is held firmly between the thumb and forefinger, and its introduction effected by a movement of supination of the wrist, or is facilitated by the use of a needle-holder.

For carrying a metallic thread, an ordinary needle of rather large size, and pretty deeply grooved behind the eye, may be employed, or one of those specially made for passing this description of suture. Of these there are three varieties—namely, that invented by Mr. Price, having two eyes, and being deeply grooved (121 a); Mr. Lister's, furnished with one eye, and grooved laterally (121 b); and that recommended by Mr. Murray, having an open end, and a groove on the side to admit of the end of the wire being doubled on itself (121 c).

FIG. 121.



The *continuous suture* is for the most part used for the accurate apposition of wounds having thin and delicate edges, such as those of the eyelids or intestines. The application consists in the simple sewing together of the wound from side to side, so that the loops of the suture cross the wound in a diagonal manner; the first stitch being tied, to prevent its pulling through. This form of suture may be fastened off by knotting together the free end of the thread with the stitch last passed, or by clamping with a small perforated shot; it can be removed by cutting with fine-pointed scissors each portion of the thread as it passes across the line of the wound, and subsequently withdrawing these portions separately. Another method of using this suture is to pass it from side to side parallel to the line of union, instead of over and across the surface of the wound.

The *interrupted suture* is more general in its adaptation than any other form, being used in wounds of almost every description. Although from its very nature it does not maintain the surfaces of a wound in such close and absolute contact as can be secured by the continuous or twisted suture, yet it possesses certain advantages over these, both in the facility with which it is applied and subsequently withdrawn (piecemeal if need be), and in that while it puts the parts in such a condition that union is most likely to take place, yet, in the event of the healing process being retarded, it offers no serious obstacle to the discharge of matter. The peculiarity from which is derived the name of this form of suture consists in the cutting of the thread after each complete stitch, and tying the ends together, over, or rather just on one side of, the line of the wound. In wounds with edges of considerable thickness and extent, the needle is generally passed separately through the opposite margins, being first introduced from the cutaneous surface towards the deeper aspect of the parts, and subsequently from the cavity of the wound towards the surface of the body.

When the interrupted suture is formed of silk or thread, it is easily removed by dividing it with the point of the scissors just away from the knot, grasping this in the forceps, and gently drawing out the suture. Metallic threads may be removed by

cutting the wire and straightening the ends before withdrawing it, or better, by cutting away a portion of the wire—nearly all the part exposed to view—and withdrawing the remainder with the forceps, pulling towards the line of the wound, so as to make the wire describe a slight curve in its exit, suited to the shape which it has assumed.

The twisted suture will retain in immediate contact the whole surfaces of a wound of considerable depth; it is employed in the operation for hare-lip, in many wounds of the face, especially such as lay open the cavity of the mouth, and in extensive wounds of the abdominal walls.

Hare-lip pins, cutting wire-pliers, and silk, twine, or some soft thick thread, are required for its application.

The edges of the wound being held in contact, or at all events being carefully maintained in the same horizontal plane, the pin should be made to transfix the wound, entering the skin from half an inch to an inch from one of its margins, and appearing at the same distance beyond the opposite. The requisite number of pins having been passed, a piece of silk, or whatever other material is chosen for the suture, should be twisted over each pin in the form of the figure 8, so that the circles of the figure surround the extremities of the pin, and the crossing of the thread lies over the line of the wound. The same thread may be made to serve for all the sutures, provided it is sufficiently long, being passed continuously from one pin to the next below it. The opposite ends of the ligature being tied together, each pin may be shortened at its pointed extremity, and adjusted so as to leave about half an inch projecting on either side. The skin may be protected from these rough-cut ends by passing beneath them a strip of soft lint; and the whole is best covered with the same material dipped in oil. In withdrawing this form of suture, the heads of the pins should be grasped in the forceps, and loosened by a slight rotatory movement; they may then be drawn out, while the finger and thumb are placed on the suture itself, to prevent any traction being exercised on the margins of the wound. When the cut surfaces, to which the twisted suture is applied, are of great thickness, it is sometimes necessary to add a few interrupted sutures at the extreme edges of the wound to prevent the eversion of the fat and subcutaneous tissue.

In applying the twisted suture to the face, or elsewhere where a slightly cicatrix is a consideration, great care is needed, in transfixing the parts, to keep the margins of the wound exactly on the same level. To avoid any doubling-in of the skin, it is well to tilt up the edges of the wound while passing the pin through them.

For this suture the softer varieties of thread possess a considerable advantage over silk or twine; the latter, from the firmness of their texture, being too apt to bruise the soft parts beneath them; on this account some adopt the plan of using narrow strips of lint to wind around the ends of the pins, or stretch india-rubber rings over these.

The quilled suture is adapted to wounds of greater depth than those to which the preceding variety of suture should be applied; of itself it can maintain in apposition the deeper parts of such a wound, and in conjunction with the interrupted suture it will keep in contact the whole surface. In the hands of some it is found very useful in the treatment of lacerated perinæum, or it is employed in deep wounds of the buttock and fleshy parts of the thigh. It is best applied with a strong curved needle fixed in a handle, and having an eye near the point. This should be threaded with the loop of a double thread, formed of some stout material; and having been passed through the wound from side to side, the looped end of the ligature may be detached from the eye and held with the left hand, while the needle is withdrawn. The needle should pierce the skin not nearer than an inch from the edge of the wound, and should traverse the deeper parts, and emerge at the same distance beyond its opposite margin. This proceeding will leave a double thread through the wound with a loop on the one side and two free ends on the opposite. Through the loop (or loops, if more than suture be employed) a piece of gum catheter should be passed, and the thread drawn tightly over it, while the other ends are tied firmly over a similar piece on the opposite side of the wound.

To maintain perfect apposition in the more superficial parts, it is generally necessary to add a few interrupted sutures at the extreme margin of the wound.

The *button* suture is employed only in exceptional instances and in particular cases, and is especially serviceable when the margins of the wound tend to separate and require support, which is afforded by the presence of a metallic plate or button. In Bozemann's suture, the button consists of a thin leaden plate, which is perforated along the middle and is fixed in position in the following manner. The edges of the wound are brought into and retained in contact by the approximation of wire sutures which have been passed in the usual manner; these are threaded through the orifices in the metallic plate, which is then slipped down so as to cover the wound, and fixed securely in position by clamped shot. Several modifications of the splint or button suture have been adopted. Mr. Lister has used two oval pieces of sheet lead, one-twentieth of an inch in thickness, each provided with a central perforation, capable of receiving a thick silver wire, which is first passed as a deep ordinary suture, then threaded through the holes in the buttons, and finally wound round the short diameter of the latter. The advantage thus obtained is the capability of relaxing the wire by simply unwinding one end of it from its button, straightening it, and allowing it to slacken as much as is required by slipping through the hole. Owing to the difficulty of unwinding the wire from the button, Dr. O. Will has fitted the latter with two studs, round which the wire is twisted in a figure-of-eight fashion.

Serres-fines are occasionally employed for bringing together wounds of very thin skin or mucous membrane. They are small spring-wire forceps; their points are finely serrated, and their handles cross one another, so that when at rest they are closely in contact. The points are generally bent at right angles to the spring, so that the handles of the *serres-fines* may lie evenly over one another along the line of the wound in an imbricated manner. In adjusting these, one should apply them at regular intervals to the lips of the wound, taking care that the handles of each pair are turned in the same direction, so as to overlap those of the preceding pair; any dressing that the wound may need can be laid on it subsequently.

COUNTER-IRRITATION.

Counter-irritants, as their name implies, are used for the purpose of exciting local irritation; they vary in degree from simple rubefacients, which merely produce transient congestion of the cutis, to such as completely destroy the tissues exposed to their influence. They may conveniently be studied in two groups:—(1) those whose effects are comparatively transient; and (2) those that excite a more permanent local irritation, or that maintain a continued drain on the system. Under the first head are included rubefacients, vesicants, acupuncture, and the like; under the second, the moxa, issues of various kinds, setons, and the actual cautery.

Rubefacients.—These produce a superficial redness and inflammation of the skin leading to desquamation of its cuticle. Mustard forms the most popular and useful of these remedies, which also include ammonia, turpentine, acetic and the mineral acids, cantharides, Burgundy pitch, mezereon, alcohol, ether, chloroform, heat and electricity.

Mustard-flour can be used in the form of tissue or mustard leaves, as they are called, or may be made into a poultice with water of a temperature from 90° to 100°; water of a higher temperature than this is liable to coagulate the albumen of the mustard-flour, while a much lower hinders the disengagement of the volatile oil upon which the irritant property of the application depends. Vinegar, which is often mixed with the poultice, has the effect of diminishing its activity. The effect of sinapisms may be in a measure regulated by mixing wheat-flour or linseed-meal with the mustard, and by modifying the duration of the time during which they remain in contact with the skin. The British Pharmacopœia directs that equal proportions of linseed-meal and mustard-flour be used; while the time during which the application should remain on may be broadly stated to vary from ten minutes to

half an hour. It may best be estimated by observing the texture of the skin of the patient, and being at the same time guided somewhat by his expressions of pain. Under no circumstance is it necessary to protract its application beyond three-quarters of an hour, and when sinapisms are employed to patients in a comatose condition, special care should be taken lest they remain for too long a time in contact with the skin, and thus lead to suppuration and ulceration. This form of rubefacient may be employed to any part of the surface of the body, though it is well not to expose the skin of the face to its influence. Very delicate or irritable skins are best guarded from its undue action by interposing a thin piece of cambric or tissue-paper beneath the poultice. After the removal of the application, the surface should be gently sponged with warm water, and a piece of cotton-wool may be placed over the part; or, if the pain be severe, a piece of linen or lint smeared with simple cerate. The volatile oil of mustard diluted with alcohol or spirits of camphor forms a useful local rubefacient. Ammonia, turpentine, cantharides and acetic acid are ordinarily employed to the surface of the skin in the form of liniment, by friction with a piece of flannel, until the skin has acquired a ruddy hue and a smart tingling is produced. Heat, either in the form of fomentations of hot water, the vapour of steam, or dry warmth, frequently has an energetic and rapid rubefacient action.

Vesicants or epispastics.—These excite superficial inflammation of the cutis and determine the effusion of serum, and an exudation of white corpuscles beneath the cuticle, detaching and raising it into a vesicle. This is followed by either absorption or discharge of the fluid, or by drying up of the vesicle, and the reproduction of the epidermis, or if the inflammation be made intense, by a further continuance of the inflammatory exudation.

To produce vesication, cantharidine in one of its various forms is generally employed; though liquor ammoniæ, chloroform, or iron heated to 212° F., are occasionally used; it is also said that mezerion-bark, soaked in vinegar, and applied to the skin, is capable of raising a blister on the surface.

Cantharidine is employed in the form of the emplastrum cantharidis, blistering fluid, and blistering tissue. The skin of the part being previously well cleansed with warm water, or sponged with vinegar, the application should be so adjusted that it may remain in close contact with the skin; for this purpose the emplastrum cantharidis is generally spread upon diachylon plaster, and the blistering tissue can be fixed with strips of the same material. In cases where, from the delicate texture of the skin, or from known idiosyncrasy, there is fear lest urinary irritation arise from absorption of the cantharidine, the surface of the blister may be dusted over with powdered camphor, or better, a piece of oiled tissue-paper may be interposed between the blister and the skin. The period during which the preparations of cantharidine should be allowed to remain in contact with the skin varies greatly, and is dependent on conditions of sex, age, and idiosyncrasy; generally speaking when the skin is thin and delicate six hours is sufficient, but when it is of a thicker and coarser texture, twelve may be required. If the desired effect is unproduced, and any considerable reddening of the surface exist, a warm linseed poultice will often determine an exudation of serum from the surface of the cutis. Vesicants are most effectual when they are applied over, or in the neighbourhood of, the affected organ; but those regions should be avoided where the bones are superficial, and the superjacent soft tissues thin, which are acted upon by the muscular movements of the body, or exposed to the pressure of the clothes, or where a raw surface exists. More effective than the plaster in its application is the ethereal extract, which is obtained by macerating the cantharidine with acetic acid and percolating with ether. This furnishes a viscid greenish fluid, which is simply painted on the skin to the extent of blistering effect required. It is especially preferable in those positions where the adhesion of the plaster is difficult, and where the patient is unruly and difficult to manage.

Vesication may be more rapidly produced by the application of the liquor ammoniæ, or iron heated in boiling water, to the surface of the body. One of the best plans of using the liquor ammoniæ is to steep a piece of lint the size of the part

to be vesicated in the strong solution, and apply it to the skin until the ammonia has passed off by evaporation; in most cases this will almost immediately raise a blister. A very manageable and speedy counter-irritant, which at the same time appears to possess a certain local anæsthetic property, has been introduced by Mr. Little, of Singapore. It consists of a small piece of lint steeped in chloroform, and covered entirely with a watch-glass, applied to the skin and gently pressed down with the palm of the warm hand. It may remain in contact with the skin from five to ten minutes, when it will generally be found to have produced pretty decided reddening of the part, and occasionally vesication. This application has been found especially suited for facial neuralgia, or rheumatic affections of the sciatic and other nerves.

To apply the heated iron as a vesicant, an ordinary hammer with a flat head, or, better, Dr. Corrigan's thermal hammer, as it is called, should be heated in a spirit lamp or plunged into boiling water for about a minute, dried, and immediately applied to the part to be blistered; the contact of one or two seconds is sufficient to produce the desired effect. Such a hammer, immersed in water at 120° F., and held for two or three seconds in contact with the skin, will act as a rubefacient; while, if allowed to remain in contact from five to ten seconds, it will generally produce vesication.

Whatever means are employed to produce the effusion of serum beneath the cuticle, the subsequent treatment of the vesicle must be pursued with one of two objects in view; either to render the injury to the part as transient as possible, and to restore the integrity of the cuticle, or to establish a permanently secreting surface. To effect the former, the vesicle, being opened with a large puncture at its most dependent part, may be allowed to empty itself; subsequently it may be covered with a layer of cotton-wool, which can remain undisturbed until the new cuticle be formed beneath; or after the evacuation of the serum, the part may be dressed with simple cerate spread on linen or lint. If, however, the blister is to kept open, the cuticle being pinched up with the forceps may be divided with the scissors around the circumference of the vesicle, and removed at once, the raw surface being dressed with the ceratum sabinæ, or whatever other application is selected as an irritant. This process of stripping off the cuticle, and at once exposing the denuded cutis to an irritant ointment and the external air, is extremely painful; the pain may, however, be avoided by leaving the cuticle in contact with the surface of the part after dividing its connections in the manner above described; the dressing may be applied over the cuticle, and the latter will separate in a few days, thus leaving a raw surface that will gradually have become inured to the stimulus of the external air.

Various irritating applications are made use of to maintain a constant secretion from blistered surfaces; the unguentum sabinæ, or the ceratum and unguentum cantharidis, are usually employed, spread on lint or linen rag. A convenient and nearly painless irritant is found in the *papier épispastique*, which is kept by most chemists: at each fresh dressing the part should be cleansed with warm water; a process needed as a general rule every day, and in summer weather twice during the twenty-four hours. There is a limit to the time during which a blistered surface should be kept discharging; when the granulations become large, spongy, or tuberculated in appearance, it is well to discontinue irritant applications, lest an uneven and unsightly cicatrix be produced.

Permanent counter-irritation may be maintained by means of the repeated application of blisters, each succeeding one being applied so soon as the one that preceded it has ceased to discharge. This plan seems to exercise a more decidedly counter-irritant effect; it is less irksome to the patient; and in chronic inflammatory affections of the joints, and analogous cases, it is an excellent substitute for some of the more formidable counter-irritants. Nitrate of silver has also been strongly recommended as a vesicant and general counter-irritant.

The most effective *pushtulants* are the tartar-emetic ointment and the croton oil liniment. Tartar-emetic in the form of ointment first induces an outbreak of papules, which by a continuance of the local remedy are converted into vesicles and pustules;

it may be rubbed into the skin twice a day, but its application requires care, otherwise ulceration, sloughs, and local gangrene are liable to ensue. Croton oil produces a similar effect, although it is less uniform in the intensity of its action, and consequently, until the degree of individual peculiarity is recognised, a dilute solution of one part to four is preferred; if the action is too mild, the strength is gradually increased until the undiluted oil is used.

Acupuncture.—This operation consists in the introduction of sharp-pointed needles into the subcutaneous tissue of the body; these are allowed to remain for a longer or shorter time, and are then withdrawn. Its chief use is in neuralgic affections, particularly those of the sciatic nerve, where it is employed for its counter-irritant effect. Its efficacy in certain obscure cases of painful muscular rigidity is highly spoken of by Dr. F. Ogier Ward, who recommends the insertion of the needles among the muscular fibres, retaining them there for some time. As a purely mechanical agent acupuncture is made use of to drain away oedematous effusions in the subcutaneous cellular tissue. The needles for this purpose are made short and strong, and fixed in cylindrical handles. They may be introduced by drilling through the skin with a rapid rotatory movement, effected between the forefinger and thumb of the right hand, the skin of the part being at the same time stretched between the fingers and thumb of the left hand; when the needle is withdrawn, the rotatory movement should be again adopted to facilitate its exit. Acupuncture is sometimes effected by percussion; the point of the needle being placed upon the skin, its handle is smartly struck so as to drive it suddenly through the integuments; lastly, the needle may be introduced with a sudden stabbing movement. In withdrawing the needle in either of the last-named methods, the skin on either side the puncture should be held down with the finger and thumb. Of the three plans the first seems to exercise the most decidedly counter-irritant effect.

Under the more permanent forms of counter-irritation are included (1) issues of various kinds; (2) setons; (3) the application of the actual cautery.

1. Issues are sores artificially produced, giving exit to a continued discharge; they are employed for local causes as counter-irritants; or for constitutional maladies, to establish a perpetual drain on the system. When instituted for the latter purpose, some part of the body should be chosen where the subcutaneous cellular tissue is abundant, and which is also convenient by its position for subsequent dressing of the sore. Prominent points of bone and the neighbourhood of large veins, or cutaneous nerves, should be carefully avoided. The upper and outer part of the arm just below the insertion of the deltoid is the common spot selected for the formation of an issue; or on the lower extremity they may be conveniently placed on the inner side of the thigh, just above the knee-joint, and clear of the saphena vein.

Issues may be established by means of (*a*) various caustics, (*b*) the moxa, or (*c*) the use of the knife.

(*a*) For the formation of caustic issues, either caustic potash or Vienna paste¹ is generally employed. To apply the caustic potash, a piece of plaster having a small hole cut in its centre, half the size of the intended issue, should be applied to the part to protect the surrounding skin; a bit of potash, the size of a small pea, may be placed over the hole in the plaster, and covered with a layer of soft lint; the whole may be retained in position by strapping, and should remain undisturbed until the caustic has exercised its full effect—that is, until it has destroyed the entire thickness of the skin; and this will generally take place in about four hours. On removing the application an ash-coloured central slough should be seen, surrounded by a bright halo of congestion. The remains of the caustic are then carefully sponged away with a solution of acetic acid, and a poultice applied until the slough separates. If a less energetic caustic action is required, the caustic potash may be mixed with soap in the proportion of three to two. Vienna paste acts more rapidly, within fifteen or twenty minutes, and is less diffuse in its action than the potash.

(*b*) The actual cautery in the form of the *moxa*, though generally employed for

¹ Vienna paste is a mixture of five parts of caustic potash with six parts of quicklime.

its immediate irritant effects, is not unfrequently made use of for the formation of issues; for this purpose it is preferred by some surgeons as exercising a more decidedly counter-irritant effect, especially in certain affections of the joints, and in carious diseases of the bones of the spinal column. The moxa is a tightly packed solid cylinder of cotton-wool, fitting into a metallic tube, open at both ends, and attached to a handle. The moxa being introduced into this tube, one end should be thoroughly ignited; and the opposite end being held in contact with the skin of the part, a continuous current of air should be maintained against its surface by means of a blowpipe, until the whole of the cotton-wool be consumed. Meantime the surrounding parts may be protected from injury by covering them with a thick layer of wet lint. The size of the eschar will be somewhat greater than that of the end of the metallic tube employed. Moxas may be prepared by soaking the cotton-wool in a strong solution of nitrate of potash, and subsequently drying them; in the application of these the use of the blowpipe may be dispensed with. The pain of the moxa is excessive during its application, but is not of long duration; and after the separation of the sloughs, the wound is generally allowed to granulate and heal up, but it may subsequently be treated as an ordinary issue.

(c) Issues are made with a knife by pinching up a fold of skin between the forefinger and thumb, rapidly transfixing it, and cutting it through, the cutting edge of the knife being turned upwards; or the integuments being put on the stretch, a crucial incision may be made extending into the subcutaneous tissue. The issue is kept open by inserting one or more glass beads into the sac left after the separation of the eschar, or produced by the knife, and retaining them in firm contact with the parts by means of strapping for four or five days. When suppuration is fully established, the wound should be cleansed daily, the peas being removed and replaced at each dressing; should the granulations become too exuberant, they may be touched occasionally with nitrate of silver. To prevent the wound healing, it is occasionally necessary to re-apply the caustic potash or Vienna paste, or to dress the surface from time to time with *papier épispastique* or some irritating ointment.

Setons.—A seton is an artificially-produced sinus, through the track of which some material is passed to excite suppuration, and to maintain the patency of its orifices. They are established in the subcutaneous tissue of the body, (a) as counter-irritants, or (b) to act as continued sources of drain on the system. As local irritants, they are passed through various cavities to excite inflammation and procure adhesion of the opposite surfaces; or again, they are used as means of gradually evacuating the contents of cysts, chronic abscesses, and other abnormal cavities. For the purposes of counter-irritation, setons are generally in the neighbourhood of the part affected; as, for instance, in front or behind the ear in certain chronic affections of the eye, or over the pubes in certain diseases of the bladder. But when employed to act as drains on the system at large, the nape of the neck is the part generally selected for their insertion. To establish a seton in the subcutaneous tissue (the part having been rendered insensible with ether spray), a fold of skin should be grasped and raised from the deeper structures; this should be transfixed at its base by the instrument carrying the seton rather obliquely, so that one of the openings in the skin shall be more dependent in position than the other. The size of the fold of skin to be transfixed will depend upon the length of the seton; but in all cases the needle must pass deeply through the subcutaneous tissue, and not immediately beneath the skin, or the latter will slough over the whole track of the wound. On the nape of the neck a longitudinal fold of skin over the spines of the cervical vertebræ is generally raised and transfixed nearly at right angles to the axis of the spine. The instruments used vary with the material of which the seton is to be composed; thus, ordinary needles of various sizes are employed when one or more silken or wire threads are to be introduced, whereas, if a gum elastic band is used to keep the wound open, a properly adapted seton-needle should be employed; though in the absence of this, the parts may be transfixed with a double-edged bistoury, which will also serve as a guide for the introduction of the seton.

Whatever material is employed to keep the wound open and excite discharge, it

should first be smeared with oil ; and, having being introduced, may be allowed to remain undisturbed for four or five days, or until suppuration is fairly established ; subsequently the dressing may be changed daily, and the seton be pulled on each occasion a little farther through the wound, care being taken to oil that part of it which is to occupy the wound before moving it. If the seton be composed of silken or other threads, when it is nearly all pulled through the wound, a fresh piece of the same material may be attached to its end, and thus drawn into the sinus. Gutta-percha or gum elastic bands need only be shifted each day one way or the other, the projecting ends being carefully wiped, so that the discharge does not accumulate and harden upon them. If the inflammation and suppuration in the track of the seton be insufficient, it may be smeared with some irritating substance, as the tincture of iodine. Occasionally it induces excessive reaction with slight febrile exacerbation, which, however, cold applications usually suffice to subdue ; but if this increase become excessive, and appear to threaten the destruction of the bridge of skin by sloughing, the seton must be removed. Exuberant development of granulations must be repressed by the application of nitrate of silver.

The *actual cautery* is some metallic substance raised to an elevated temperature, and applied to the tissues of the body ; steel, iron, and platinum are the only metals now employed for this purpose. This form of cautery is made use of for arresting hæmorrhage, for destroying diseased surfaces and morbid growths, and for exciting counter-irritation of almost every degree, from simple rubefaction up to complete destruction of the skin and subcutaneous tissue.

Cauteries are made of steel, fixed in wooden handles ; their heads or extremities are of various shapes, being bulbous, conical, hatchet-shaped, or hammer-headed, varying with the special purpose or part of the body to which they are applied. They may be heated in an ordinary fire, or by means of a spirit-lamp. Three degrees of temperature are generally recognised ; namely, white heat, red heat, and an inferior degree when the metal is black, or as hot as it can be without losing its natural colour. As a general rule, the hotter the metal is at the time of application, the less pain will it produce. The well-known gas cautery apparatus devised by the late Mr. Bruce is a most convenient and valuable form of cautery, but is now almost superseded by the 'benzoline' or Paquelin's cautery, described at p. 656.

In making use of the actual cautery to a raw surface, for the purpose of staying hæmorrhage, a dull red or black heat will be most effective. If the bleeding proceeded from a single point, the touch of a conical or an olive-shaped cautery is mostly sufficient for its restraint ; but when this is more extensive and profuse, the surface having been momentarily dried by the application of a sponge, the cautery iron, of a flat or rounded shape, is passed rapidly and lightly over the surface, not being allowed to remain in contact with any one part of the wound for more than a second or two, otherwise the disorganised tissues will stick to the metal, causing great pain and often considerable hæmorrhage when the instrument is removed. For the destruction of morbid growths or cancerous ulcers, the cautery should be raised to a light red heat, and allowed to remain in contact with the diseased tissues and frequently renewed until complete charring of the parts has been effected, or the gas cautery or Paquelin's apparatus may be employed. When the hot iron is applied to the sound skin for its counter-irritant effects, a hatchet-shaped cautery at a white heat is generally employed ; the thin edge of this may be drawn rapidly and lightly over the surface in parallel lines, an inch or more apart. There are certain parts of the body to which this remedial measure should not be applied ; these may be stated to be the immediate neighbourhood of subcutaneous bones, such as the vault of the skull and the sternum ; salient points of bone, as the acromion, olecranon, patella ; the course of the larynx or trachea ; superficial tendons, and the neighbourhood of such synovial membranes as lie very near the surface. The effect of the heated iron may be varied in degree by holding it at a greater or less distance from the skin. In direct application it is thus employed by many continental surgeons as a stimulant to ulcers or unhealthy wounds ; the cautery being held first at some distance from the part, and being gradually approximated until the surface of the sore is covered with a thin dry scab.

BLOOD-LETTING.

For the convenience of description, this remedial measure may be considered first in its local, and secondly in its general application. In local blood-letting the blood is drawn from the capillaries; this may be effected by leeching, scarification, or cupping. General blood-letting includes venesection and arteriotomy.

Leeching.—Leeches should be removed from water an hour or two before their application, and, having been carefully dried in a clean cloth, they may be applied to the skin of the part, after it has been carefully cleansed, freed from hair, if that exist in any quantity, and, if need be, smeared with a little milk to induce the leeches to bite. If the blood is to be abstracted from the external surface of the body, the leeches may be conveniently covered with an inverted tumbler or wine-glass until they have attached themselves; or they may be placed in the hollow of a large and loosely made pad of cotton-wool covered with lint; or a clean towel may be folded so as to contain them, and being inverted over the part, may be maintained in position by gentle pressure. Again, two or three may be placed together in an open pill-box, which must be inverted and maintained in contact with the part. When it is desirable more exactly to localise the point of application, as in leeching the gums, eyelid, or lacrymal sac, the leech can be retained in position until it has attached itself by means of a leech-glass, or a card rolled up in a cylindrical shape. When there are but few leeches to be applied to the external surface of the body, each may be held singly between the forefinger and thumb, while its mouth is directed to the part to which it is intended it should attach itself. Some precautions are necessary in their application. When they are applied to or in the neighbourhood of the cavities or canals of the body, a leech-glass or rolled card should be used. Care should also be taken that they do not bite over superficial vessels of some magnitude, so that by wounding the latter troublesome hæmorrhage may ensue. Parts that are especially sensitive, or are provided with loose cellular tissue, such as the lids, or are protected by a thick epidermal layer, as the palms and soles, are also to be avoided.

A healthy leech will draw about ʒij. of blood, and this quantity may be increased by subsequent fomentation of the bite to about ʒss. It is said that the capacity for abstracting blood may be largely increased in leeches by making minute punctures on their dorsal surface, just above the caudal extremity; of course this proceeding cannot be adopted until the leech is firmly attached and well distended with blood; it is a measure, one would think, of very equivocal advantage. When leeches, though fully distended, still remain attached to the surface, the popular applications of salt or snuff to their bodies will generally induce them to relax their hold.

To obtain a further flow of blood from the bites after the separation of the leeches, warm linseed poultices or fomentation with warm flannels are generally employed, or the part, if on one of the extremities of the body, may be immersed in warm water. When it is desirable to arrest the hæmorrhage at once, the bites may be freely exposed to the air, or the part being covered with lint or a dry cloth, pressure over it may be made with the hand, or maintained by a bandage; should this be insufficient, a little shredded lint being placed over each bite, firm pressure may be made with the finger-ends; or, again, the bleeding points may be touched with nitrate of silver or perchloride of iron. In cases where the hæmorrhage is alarming, or the foregoing means have failed to arrest it, the soft parts beneath the bite may be transfixed by a fine needle, and a silk ligature may be wound around them beneath the needle-ends. Besides hæmorrhage, other accidents have been known to accompany or follow leeching, such as faintness, severe pain, and even convulsions, whilst the puncture may inflame and even suppurate, or be followed by an erysipelatous affection.

Scarification is employed in various parts of the body, as a means of directly relieving the local congestions of free surfaces. The operation consists in making small incisions on the surface of the part with the point of a lancet or scalpel; these incisions varying in depth and extent with the texture of the part affected and the

severity of the local mischief. They are employed in chemosis of the conjunctiva, phlegmonous inflammation of the integuments, acute engorgements of the tongue and tonsils, and in other parts.

Cupping in its most ordinary form consists in the local abstraction of blood from minute incisions by means of atmospheric pressure; cupping-glasses, a scarificator, and a spirit-lamp are required for the performance of this operation. Cupping-glasses are of various forms and sizes, but, for the most part, narrow at their necks and somewhat dilated at the opposite extremity. They are employed for creating a partial vacuum over that part of the surface from which the blood is abstracted; the air within them is rarefied by introducing for a second or two the flame of a spirit-lamp; on the withdrawal of this, the open mouth of the glass is immediately applied to the part to be cupped. This has the effect of producing great local congestion and swelling up of the parts included within the rim of the glass. In other varieties of cupping-glasses which are occasionally used, the rarefaction of the air is effected either by an exhausting syringe fitting on to the glass, which is provided with a stopcock or valve, or by means of an india-rubber ball above the cupping-glass, which is compressed and emptied before application is made; but neither of these modifications is as efficacious as the ordinary method. The glass may be conveniently removed by tilting it to one side, and at the same time insinuating the point of the forefinger under its edge on the opposite side. The *scarificator* is used for simultaneously and quickly effecting the necessary incisions for the abstraction of blood; it is formed of a number of blades fixed on an axis, which latter, by a rapid semi-rotatory movement, projects the blades through appropriate openings in the instrument, and divides the integument to the required depth. Before its application the blades of the scarificator should be set so as to cut through the cutis vera, but not to encroach upon the subcutaneous tissue; this being effected, the spring may be drawn back, and set, and the instrument being held pretty firmly in contact with the skin, the spring may be released.

Before the application of cupping-glasses the skin of the part should be sponged with warm water, and any hair there may be on the surface should be removed; a basin of warm water and a lighted candle should be at hand. The glasses being first placed in the warm water, should be applied, in the manner above mentioned, one by one to the part from which the blood is to be drawn; care being taken that sufficient intervals are left between the glasses: they may be allowed to remain in contact with the skin for about a minute; as each is withdrawn, the scarificator should be applied to the swollen integument beneath, and the glass should be as quickly as possible readjusted to the part. The blood will continue to flow from the incisions until the exhaustive power of the glass has ceased by the vacuum within being destroyed; when this occurs, the glass may be removed, and a fresh one may be applied to the same spot, the surface being first sponged to remove any coagula that may have formed. As each glass is removed, the blood from it may be emptied into a graduated vessel. When the required amount has been abstracted, the wounds may be sponged, dried, and each group covered with a piece of diachylon plaster.

It is often extremely difficult to procure the required amount of blood by means of cupping; and this, though it may occur from many causes, is chiefly owing to one of two reasons—namely, that either the depth of the incisions has not been rightly adapted to the thickness of the skin of the part, or that the vacuum within the glass is insufficient or too complete. To avoid both these evils requires some knowledge of the different thickness of the integument on various parts of the body, and a certain manual skill which can only be acquired by practice. When the skin has been too freely divided by the scarificator, the subcutaneous tissue is apt to bulge through the incisions in the skin and hinder the flow of blood, while the disadvantages of an insufficient division are obvious. Should the atmospheric pressure be so great as to constrict the cutaneous capillaries around the rim of the glass, this pressure may be relieved by rotating the glass a little, or by swaying it to and fro, so as to allow a little external air to get beneath its margin.

There remains to speak of another form of cupping, usually termed 'dry cupping.' The object of this is to abstract blood temporarily from one part of the body by detaining it for a time in other parts. To effect this, several cupping-glasses are applied and renewed at intervals, their position being slightly varied each time, so that the skin may not suffer from the pressure.

M. Junot has devised an instrument by which he considers that he produces a transient condition of general depletion. The apparatus consists of a metallic cylinder closed at one extremity, and sufficiently large to contain either the upper or lower limb; attached to the cylinder is a small stopcock, to which is fitted an exhausting syringe. One of the limbs is immersed in the metallic case, and a very wide india-rubber band being drawn over the open end and around the limb, so as to form an air-tight cavity, the syringe is applied until the condition of the pulse indicates that a sufficient amount of air has been removed.

General Blood-letting.

Venesection.—This operation may be performed upon the veins of the forearm or hand, the external jugular, the veins beneath the tongue, those of the scrotum, and the internal saphena, near the inner ankle. Whatever vein is opened, it is necessary, when practicable, to produce congestion of it, by compressing the vessel between the point to be opened and the heart. A lancet, bleeding-tape or a narrow bandage, lint, a bowl to receive the blood, and a basin of water and a sponge, are required. The operation, as ordinarily performed in this country, consists in opening one of the veins at the bend of the elbow. Of these the most prominent are the median cephalic and the median basilic, the former being situated to the outer side of the tendon of the biceps, the latter to its inner side, and immediately over the course of the brachial artery, indeed only separated from the artery by the fascial attachment of the biceps muscle. For anatomical reasons, therefore, the median cephalic should be preferred for venesection; but in practice the more prominent and larger vein of the two is selected.

The patient being placed in the sitting posture, the bleeding tape or bandage may be tied around the limb about the middle of the upper arm, sufficiently tight to arrest the venous circulation without affecting the pulse at the wrist. The forearm having been allowed to hang down until the veins are tense and turgid, the operator may select one for his purpose, and taking the blade of the lancet between the forefinger and thumb of his right hand, should fix the vein by pressing his left thumb upon it, just below the part he is about to open. Steadying his hand by resting the ends of the three inner fingers on the forearm, the point of the lancet may be introduced obliquely until the interior of the vein is reached and the blood rises up out of the wound; without penetrating any deeper, the lancet should now be thrust onwards, thus laying open the vein longitudinally, and cutting its way out in advance of the point of puncture. The vein being well opened, the thumb may be removed, and the blood allowed to flow; if the stream be scanty and sluggish, the ordinary expedient may be adopted of directing the patient to clench his fist firmly from time to time, or the surgeon may chafe the veins on the palmar surface of the forearm, rubbing from below upward. When the required amount of blood has been abstracted, the thumb of the left hand may be placed over the wound, and the ligature around the arm relaxed; a small pad of lint being placed over the orifice in the vein, the parts around should be cleansed from blood, and the tape applied in the figure-of-eight fashion, so that the crossing of the tape lies over the pad on the vein and keeps it in place, exercising pretty firm pressure (fig. 116 F, p. 628).

The operation is not always free from difficulty and complication. Occasionally the veins at the bend of the elbow are not discernible either by the eye or the finger, either from their small size and imperfect development, or from the excessively thick layer of adipose tissue in which they are embedded. If no trace of the vessels can be discovered after careful examination by the finger, it will be necessary to select some other locality, such as the forearm or hand. Again, in emaciated subjects, the mobility of the vein in the loose surrounding cellular tissue may enable it to evade the punc-

ture by the lancet, and the vessel should therefore, in these cases, be firmly fixed by the thumb, and the opening made close to the latter. After the vein has been fairly opened, certain circumstances may interfere to prevent or retard the flow of the stream of blood, and the most important of these is the loss of parallelism between the opening in the vein and that in the skin, a displacement which is the consequence usually of some movement of the arm or traction on the skin, and is repaired by restoring the limb to the position it possessed when the vein was opened. The orifice in the skin may become occluded by a nodule of fat, which is best cut away by the scissors; or that in the vein may become obstructed by a small coagulum, the removal of which is effected by accelerating as much as possible by friction and muscular movements the force of the escaping current. A too tightly or too loosely applied bandage, or the sudden onset of syncope, will have the effect of preventing the flow of blood. The most serious accident liable to happen during the performance of the operation is a wound of the brachial artery, an injury only possible when the median basilic vein has been selected, and which can always be avoided by the exercise of a moderate degree of care, by not sinking the lancet too deeply, and by carefully localising the position of the artery before operation. It is recognised by the mixture of the arterial and venous blood which escapes, and by the fact that after removing the tape, the blood escapes with greater force. Sugillation, or effusion of blood into the subcutaneous tissue, is observed when the external opening is too small, or when this does not correspond with that in the vein. In the latter case, whilst the blood escapes in a thin stream externally, a circumscribed swelling forms and rapidly increases, at first soft and then increasing in hardness as coagulation ensues. This effusion of blood has been called a thrombus, and usually disappears spontaneously by absorption within a few days after its formation, or may become inflamed. Inflammation of the lymphatics or of the vein is sometimes seen after a venesection, and is attributable to the use of blunt or unclean instruments, to a too early movement of the arm after operation, to the use of plasters, &c. Severe and persistent pain may likewise follow the wound of one of the cutaneous nerves which surround the vein in this position.

In children, and occasionally in others, where the subcutaneous veins at the bend of the elbow are ill-defined or of small size, venesection is practised on the external jugular. For this a pretty bulky pad of lint is required; it should be applied over the vein in the hollow just above the clavicle and external to the sterno-mastoid muscle, and should be secured by a bandage passed over it and fastened in the opposite axilla, so as to exercise firm pressure on the vein, and prevent the possibility of the entrance of air into the circulation. The part of the vessel generally chosen for the operation is where it overlies and crosses the sterno-mastoid; the vein being fixed with the thumb of the left hand, the incision may be made in the same manner as in bleeding at the bend of the elbow, the line of the wound being parallel to the fibres of the sterno-mastoid muscle, so as to secure a transverse division of the platysma myoides. The blood can be directed into a bowl by means of a piece of cardboard folded in the form of a gutter, or it may be collected in a teacup held close below the wound. To arrest the bleeding, a pad must be applied over the wound, and retained by strips of plaster; the compress over the clavicle may then be removed.

Venesection in the foot is performed either from the dorsal venous network, or more usually from the internal saphena just above the malleolus; the patient is made to sit with the foot in a warm bath, and as soon as the veins have become distended, a circular bandage is applied just above the ankle, and the foot once more placed in the water until the veins are sufficiently engorged. The introduction of the lancet requires some degree of force, on account of the skin being coarser and thicker here than at the elbow, and an aponeurosis existing between the skin and the vein. On the other hand, it should not be pushed in too deeply, otherwise there is a risk of injury to the ligaments or periosteum, or of breaking the lancet in the bone; generally the blood flows sluggishly, and to encourage the flow the foot is kept immersed in the warm water.

The cutaneous veins of the scrotum may be opened in cases of acute orchitis, the bleeding being encouraged by warm fomentations, and arrested when necessary by exposing the part to the external air or by the application of cold water.

Arteriotomy.—The only vessel on which this operation is practised is the temporal artery itself, or one of its principal branches; the main trunk of the vessel may be found crossing the zygoma at right angles about half an inch in front of the pinna of the ear, and just above this spot the artery divides into its anterior and posterior branch. A small bistoury or a lancet, a narrow bandage, a small firm compress, sponge and water, and a bleeding-bowl, are required for this operation. The position of the anterior division of the vessel being ascertained, or that of the main trunk itself if the former be of insufficient size, its exact situation should be marked, and the vessel may be at the same time fixed by placing the forefinger or thumb upon it, just below the point where it is to be opened. The blood should be drawn from a transverse wound in the vessel, made by cutting down upon it with a bistoury; or with a lancet, by first puncturing its coats and then laying open its canal more freely. To arrest the hæmorrhage, the artery may be completely divided, the part sponged, the compress applied to the wound and secured by the knotted form of bandage (fig. 117, p. 629). This should be most carefully adjusted, so that it may remain undisturbed for four or five days, when it may be removed, and the wound covered with a strip or two of plaster.

VACCINATION.

The object of the operation of vaccination is to inject the vaccine lymph into the superficial part of the cutis, and thereby to procure its absorption into the system. It has been performed in several ways, and by various instruments, but the most general practice is that of puncture by the ordinary or grooved lancet, performed according to the following directions:

The patient's left arm should be grasped in the operator's left hand, just above the insertion of the deltoid muscle, and the skin on the outer aspect of the part put on the stretch. The lancet having been charged with lymph taken from the vesicle not later than the eighth day after inoculation, is held with the flat of its blade turned towards the surface, and is made to perforate the cuticle very obliquely from above, so that its point may just penetrate the superficial layer of the cutis; this may be effected without causing any hæmorrhage, or at most, not more than a drop of blood need escape. As it is withdrawn, the lancet may be pressed against the raw surface of the cutis, or the thumb of the left hand may be used to press the edges of the puncture together, so as to wipe the virus off the point; five or six punctures may thus be made about half an inch distant from each other, the lymph, thus introduced, being retained by the valvular character of the punctures. Other modifications of the method of puncture have been introduced, such as rubbing the lymph with the flat of the lancet, into a number of minute superficial punctures, or by first smearing the lymph on the skin, and then raising the cuticle in a number of places over this area with the sharp point of the lancet. Instead of the lancet, a grooved needle is sometimes made use of, or Spratley's vaccinator, which consists of a needle with an arrow-headed point having a groove on one surface, and a small rectangular shoulder about one-twelfth of an inch from the point. The vaccinator of Dr. Braidwood consists of a double blade approximated in a manner similar to P. A. Valentin's knife, and is charged by puncturing the vesicle with its point, and allowing the lymph to flow between its blades. With the charged instrument a small incision is made in the skin for each vesicle. Other operators have preferred to expose the cutis for the purpose of absorption, by removing the epidermis by scratching. This is accomplished with the point of the lancet or needle, by which a number of scratches are made close and parallel to each other, or in a crossed manner, and sufficiently deep to expose the cutis. If a little blood oozes, it should be wiped off, and the lymph rubbed over the ulcerated surface. The number of places thus treated will depend upon their size; if only sufficiently large to produce a single

vesicle, five or six are necessary. Dr. Weir substitutes a scraper, consisting of four fine needle-points, set in a handle, for the lancet, and other instruments have been invented for removing the epidermis in this manner. Dr. Cooper Rose employs five minute points, which are pressed firmly against the skin and rotated, and Dr. Hilliard has constructed a vaccinator in the form of a mathematical or drawing pen, the blades of which retain the lymph between them by capillarity, and when this is drawn upon the skin, it lodges the lymph in the scratch thus made. Experiments have also been made with vesication for the purpose of exposing the cutis, but the difficulty of limiting its action to the production of a small vesicle deprives this method of much practical utility. It has, however, been suggested to overcome this objection by inserting the blistering fluid beneath the cuticle with an exploring needle so as to obtain small vesicles.

Arm to arm vaccination with fresh lymph, although on all occasions it is to be preferred, is not always possible, and it then becomes necessary to collect the lymph and preserve it for subsequent use. It is preserved either in a dry state on ivory points or between glass slides, or in a fluid condition, in Husband's capillary tubes. The ivory points are charged in the following manner: When the vaccine vesicle is fully matured, the eighth day after vaccination, it is opened on the summit with the point of the lancet by a number of small punctures, and the lymph allowed to exude. Into this the sharp ends of the ivory points are dipped twice, and the lymph allowed to dry. This is repeated with other points until the lymph is exhausted, and the surface becomes dry. Great care should be taken in collecting the lymph to prevent its admixture with any blood. Enough lymph should thus be furnished from a single well-developed vesicle to charge six to eight points, although the number is variable according to the size and quality of the vesicle. The capillary tubes are from two to four inches in length, and about $\frac{1}{28}$ of an inch in diameter, their walls being $\frac{1}{24}$ of an inch in thickness, and are filled by applying one end of the tube, held horizontally to the exuding lymph, which enters immediately. As a general rule, each tube should not be charged with more than will suffice for one vaccination. It may be sealed in the following way: The lymph is first made to gravitate towards the middle, by holding the tube vertically, and if necessary giving it a few slight shocks by striking the wrist on the arm or table. The end by which the lymph entered may then be sealed, by applying it to the surface of the flame of a candle. The other end should first be plunged about half an inch into the flame to expel the air, and as quickly withdrawn till it touches the surface, where it should be held till it melts over and is sealed. Not more than a minute or two should elapse between charging the tube with lymph and sealing it up, or the lymph will concrete at the orifice, and cannot then be forced into the centre of the tube.

To vaccinate with lymph which is preserved fluid in the capillary tube all that is necessary is to break off its hermetically-sealed extremities, and blow out the lymph gently on the point of the lancet or vaccinating instrument; but when it has been preserved dry, it must be rendered moist before it can be made serviceable. This is effected, when the lymph is between glass, by adding a small quantity of water sufficient to moisten it, and mixing the two with the lancet. The points should be moistened by dipping quickly into warm water, and used by inserting the moistened apex into the puncture made by the lancet, or simply rubbing it over the surface, which has been abraded by scratching.

The result of primary successful vaccination may be stated to be as follows: the puncture may be felt slightly elevated on the second day; on the third it is surrounded by a slight halo of redness; by the fifth a distinct vesicle will be formed, having a slightly elevated margin and a depressed centre; on the eighth day the vesicle should have reached its perfect condition, when it is pearl-coloured, and distended with clear lymph, its margin being turgid, firm, and shining. From this period the redness around increases in extent and intensity until the tenth day, when there is often well-marked swelling, and induration of the subjacent cellular tissue. On the eleventh day the areola begins to subside, leaving as it fades two or three concentric rings of redness; the vesicle begins to dry up, assuming a brownish

colour; the remaining lymph becomes opaque, and gradually concretes, forming by the fourteenth or fifteenth day a dry reddish-brown scab, which falls about the twenty-first day, and leaves a permanent, slightly depressed, and pitted cicatrix.

Revaccination occasionally runs the same course as primary vaccination, but far more generally its results are variously modified; either no true vesicle forms, or it attains its maturity and runs its course with greater rapidity than the regular vesicle. The areolæ also tend to diffuse themselves more widely and less regularly than in primary vaccination, and the local changes are accompanied by much itching, often by some irritation of the axillary glands, and in some cases by considerable febrile disturbance supervening on the fourth or fifth day.

The disadvantages which have been said to attend the use of humanized lymph for vaccination, of which the most important are the risks of transferring constitutional disorders, and its diminished protective power caused by its deterioration from gradual attenuation in passing through successive generations, have led of late to a more extended use of the practice of vaccinating directly from the calf. Without entering here upon the legitimacy or validity of these objections to the human lymph, it may be said that the performance of animal vaccination differs in no essential degree from that already described. The lymph is obtained from the vaccination of calves kept for the purpose with that originally derived from some spontaneous case of cow-pox, and transmitted uninterrupted and exclusively through the animal. It is most successful when vaccinated directly from the calf, although it may be preserved in a manner similar to human lymph; but must be used within a short time of its collection, otherwise failures are frequent.

HYPOTERMIC INJECTION.

The hypodermic system of medication consists of introducing concentrated solutions of therapeutic agents into the subcutaneous cellular tissue with the object of expediting their absorption and intensifying their action. Its use, originally intended and even now chiefly devoted to the injection of anodynes, opium and morphia, has since been adopted not only for a large number of other constitutional remedies, including hæmostatics, emetics, antiperiodics, purgatives, &c., but also for the purpose of obtaining a local effect: as in the treatment of erysipelas by injection of carbolic acid. As an operation it is one of the simplest in minor surgery, all that is requisite for its performance being a small syringe and the solution for injection. The syringe is a graduated tube usually constructed of glass, capable of containing five to ten minims, fitted with a sliding piston, which should work easily, yet tightly, in the tube; or in a metal continuation of this, and provided with two hollow sharp-pointed steel needles of different sizes, which are screwed on to the nozzle of the barrel when the syringe is used. Many modifications exist in its construction, among which may be mentioned the varying capacity of the syringe, the use of a screw in place of a sliding piston, the graduation on the piston-rod instead of on the glass barrel, and others which do not admit of a detailed description in this place. Before injecting, the syringe is first filled with the requisite amount of the solution, reversed, and the air expelled by pressing the piston-rod until a drop of fluid appears at the orifice of the needle; it is then held between the thumb and forefinger of the right hand, and a fold of skin having been raised by the other hand at the part selected for injection (usually on the inner side of the forearm), the needle is thrust with a rapid movement through the skin at the base of the fold, until the cessation of resistance to its penetration shows that the point has reached the subcutaneous cellular tissue. It is then pushed onwards so as to lie well within the cellular tissue, the fold of skin relaxed, and the fluid slowly injected by pressing the piston downwards with the thumb. If the needle is slightly drawn backwards at the same time, the fluid becomes more diffused and produces less tension in the tissue. The instrument is then withdrawn, the orifice in the skin being compressed by the finger to prevent any escape of the fluid. Another method of injection which has been recommended is to put the skin of the limb tightly on the stretch by surrounding it with the thumb and fingers of one

hand, and to plunge the needle of the syringe through the skin, thus made tense, into the cellular tissue. After use the syringe and needle should be cleaned and dried, and a fine stilet of silver wire inserted into the needle to keep it patent. Simple as this operation is in its execution, it is on some occasions not wholly free from accident and disagreeable consequences. The pain with which it is accompanied may be greatly exaggerated, either from unskilful application, or from excessive distension of the cellular tissue with the fluid, or from injecting this into the dense and unyielding cutis; but with practice is reduced to a trivial degree. Hæmorrhage is generally absent, but occasionally, if some cutaneous vessel be punctured, some bleeding ensues which is easily controlled by compression. On rare occasions the injection has been immediately followed by most alarming and unexpected symptoms of sudden faintness, collapse, and apparent imminent dissolution; these are attributable to the direct injection of the morphia solution into the circulation by puncturing a vein with the needle, and in order to avoid the possibility of such a complication it is advisable to avoid entering the needle over any cutaneous vein; or to introduce it separately, and watch if any blood escape, before attaching the syringe. In the majority of cases the fluid is rapidly absorbed from the cellular tissue, and the slight swelling disappears without further inconvenience, but occasionally irritation at the site of puncture is excited, inflammation ensues, and abscesses, ulceration, or even sloughing of the skin may follow. Such an undesirable result is liable to follow the use of blunt or unclean instruments or too voluminous injections, or is due to some irritating qualities of the injected fluid. The needle may even be the medium of introduction of septic infection, and therefore the strictest precautions as to cleanliness cannot be too rigidly adhered to.

The fluid for injection should be recently prepared, and not have been too long or badly kept. It should be free from any sediment, filtered, and as neutral in reaction as possible. Simple distilled water is the most preferable vehicle for the solution, and if the latter become turbid from crystallisation, it may be cleared by warming it. The morphia solutions are composed either of the acetate or hydrochlorate, and according to the British Pharmacopœia have a strength of one grain to twelve minims; if a stronger solution be required, it may be obtained by rubbing ten grains of the acetate gradually with a drachm of water, and adding a few drops of acetic acid if necessary for perfect solution. This will have a strength of one grain to six minims. The hypodermic solution of atropia is prepared by dissolving a quarter of a grain in a drachm of distilled water, and injecting from two to four minims; when combined with morphia, one grain of the sulphate of atropia is dissolved in six drachms of the pharmacopœial hypodermic solution of morphia, three minims of which will then contain one-quarter of a grain of the acetate, and $\frac{1}{120}$ of a grain of the sulphate.

CAUSTICS.

The various substances used for destroying morbid growths or the tissues of the body by chemical agency are generally termed potential cauteries. They produce these results partly by the withdrawal of water from the tissues, and partly by certain chemical changes and combinations between the escharotic and the tissues. Compared with the actual cautery, they act more slowly, cause less intense but more persistent and less tolerable pain, form a moister eschar, which separates slowly, and extends more deeply and widely into the tissues. They are to be preferred when a large mass of tissue is to be destroyed. Before their application, the surface to which they are to be applied must be cleansed from blood, pus, and mucus, and the neighbouring parts protected from their influence by cotton-wool soaked in some neutralising fluid. The classes in which they arrange themselves are the solid and fluid caustics, under which headings they will be described.

SOLID.—*Caustic potash* is prepared in cylindrical sticks of a greyish colour which deliquesce rapidly on exposure to the air. In contact with the tissues it liquefies and destroys them, forming a soft semi-fluid mass, which gradually dries into a black eschar, followed by inflammation of the surrounding parts and separation at the

end of six days. It is not suitable where a limited destruction of tissue is required, but especially adapted for destroying ulcerations, lupoid tubercles, new-growths, opening undermined abscesses and suppurating glands, and has also been employed to procure adhesion of serous surfaces, preparatory to opening abscesses in the liver. When combined with lime, Pot. c. calce, Vienna paste, in the proportion of six to five, it is not so deliquescent, and more easily manipulated. It may also be made into a paste with alcohol, and applied to the surface to be destroyed.

Arsenic acts very energetically on diseased structures as an escharotic, but is inert on surfaces protected by epithelium. Considerable and sometimes enduring pain follows its use, accompanied with no little irritation and inflammation of the surrounding parts, and the eschar is slow to separate. It is usually diluted with various inert substances to the required extent, and then used in the form of a paste or ointment. The arsenical paste most in use in this country is that first employed by Baron Dupuytren; it consists of a mixture of calomel and white arsenic, in the proportion of from six to ten parts, by weight, of the latter to a hundred of the former. This being made into a paste with mucilage or a little water may be applied to the surface of the parts, either directly or spread on lint or a piece of blotting-paper. The formerly celebrated Cosme's powder consisted of a mixture of white arsenic, cinnabar, and 'dragon's blood' made into a paste with water or saliva. Sir A. Cooper recommended an ointment composed of a drachm of arsenic, a drachm of sulphur and an ounce of ung. cetacei. Particular formulæ are, however, of little importance, all that is necessary being to incorporate the caustic with from four to eight parts of some inert substance, and apply it in the form of ointment or paste. The efficacy of this caustic is undoubted in the treatment of lupous, rodent, and other intractable ulcers; but there exists the obvious objection to its use, that unless it is employed in a strong concentrated form, so as to actively destroy, there is considerable danger of its absorption into the system. Indeed, a case is related in the practice of M. Roux where the application during a single night of a paste, containing four per cent. of arsenic, to a surface of little more than an inch in diameter proved fatal, and Graham mentions a fatal case after the application of a plaster containing half its weight of arsenic to a cancerous breast.

Chloride of zinc is a powerful caustic, the action of which extends deeply, and forms a whitish, dry and inodorous eschar; little inflammation is excited in surrounding tissues; and decomposition in the wound, if it previously existed, is at once arrested. Nor does the slough itself show any tendency to putrefy. It takes some hours to produce its full effect, produces considerable pain, but not so acute or enduring as that caused by arsenical paste, and has the advantage of leaving a very contractile wound, evidence of which becomes obvious even before the separation of the slough.

Chloride of zinc forms the active ingredient of many of the most popular and effective caustics; mixed with variable proportions of flour, it constitutes Canquoin's paste; combined with equal parts of the chlorides of antimony, bromine, and gold, it enters into the formation of Landolphi's caustic. It has the disadvantage of being deliquescent, and is used in a dry form, as a powder, or in solution, or as a paste. In the form of powder, it is mixed either with equal parts of oxide of zinc, or the anhydrous sulphate of lime; in the form of Sir W. Burnett's solution it is diluted with seven parts of water; and as a paste in the proportion of one part of the dry chloride to two, three, or four parts of flour or plaster of Paris. A very convenient formula for the latter is that in use at the Middlesex Hospital, in which 480 grains of the chloride and 180 grains of flour are mixed with an ounce of water, or the liquor opii sedativus, and subjected to the heat of a water-bath for a few minutes until a paste of a treacly consistency is formed. It is employed to destroy ulcerated surfaces, or to remove solid growths of various kinds; it should not be applied to any but an ulcerated, abraded, or denuded surface, as its action upon the parts protected by their epithelial covering is both slow and extremely painful. The solution may be applied on pieces of lint cut rather smaller in extent than the intended slough, and the paste spread on lint in a layer varying in thickness with

the depth of the part to be destroyed. In attacking solid growths with the chloride, the external cuticle is first removed by vesication or destroyed by nitric acid, and the paste smeared on lint applied to the exposed surface. As soon as the slough is fully formed, incisions parallel to and at a short distance from each other are made with a scalpel through the dead parts until the living growth beneath is reached, a fact recognised by the difference in sensation which is felt as the knife enters the soft living texture, and by the appearance of hæmorrhage. These are stuffed with strips of lint smeared with the paste, and the same process continued at intervals of two or three days until the whole substance of the growth is destroyed, when the dry, inodorous eschar is permitted to separate.

Sulphate of zinc, introduced by Sir J. Simpson, is used either in the form of finely levigated powder, as a paste, composed of one drachm of glycerine rubbed up with an ounce of the powder, or as an ointment made in the proportion of two drachms of lard to an ounce of the dried sulphate.

It is applicable to ulcerations of the os uteri, rodent and lupous sores, or indeed to almost any form of obstinate or inveterate ulceration. For destroying warts and condylomata, and the vascular growths about the female urethra, it is said to be most efficacious. The slough is of a white colour, and usually separates about the fifth day, leaving behind it (if the whole morbid tissue be removed) a red granulating, healthy, and rapidly cicatrising wound. The disorganised tissues show no tendency to decompose, but are firm and inodorous. This caustic will only act on ulcerated or abraded surfaces; where the epithelium therefore is entire, the part must be prepared for its application by the previous use of the nitric acid or some other of the stronger caustics. The pain produced by the sulphate of zinc is said to be less enduring than that caused by caustics generally, the local inflammation is very slight, and the eschar has been observed to separate in most cases about the fifth or sixth day.

Chromic acid, in the form of red deliquescent crystals, is an active oxidising agent, and will dissolve almost any tissue. It is very effective in destroying condylomata and warts, or phagedenic or diphtheritic ulcerations, when employed either as the solid crystal, with care to limit its action, or in solution by touching the surface to be destroyed with the liquid of deliquescence by means of a glass rod. Care must be taken in its application, as it is a violent poison, and when used extensively has been followed by vomiting, diarrhoea, collapse, and even death.

Nitrate of silver, when applied in the solid form to moist surfaces and mucous membranes, forms a white layer which is due to its insoluble combination with the albuminates of the tissues and which limits its further action. From this cause the eschar which results is always superficial. When applied dry to sound surfaces, it produces little effect, but when moistened it destroys the cuticle and even the true skin, or, with a shorter period of contact, vesicates. The pain produced frequently lasts for some hours, and its action is usually rapid, and excites but slight irritation or inflammation in the surrounding tissues. In the solid form this salt is applied either by lightly brushing it over the part, producing a thin scale of dead tissue, of a bluish-white colour, turning to black; or by rubbing it firmly again and again over the surface, so as thoroughly to destroy the part to a more considerable depth. In solution nitrate of silver is applied with a camel's-hair brush or a small piece of sponge, the caustic effect being far less marked than when used in the solid form; it is chiefly of use in checking exuberant granulations, in destroying the surfaces of unhealthy ulcers or secreting cysts, in stimulating flagging sores, in producing a superficial slough on the surface of poisoned wounds, thereby diminishing their absorbent power, or for destroying warts and small condylomatous growths.

Sulphate of copper exercises sufficient caustic activity to be employed for the destruction of warts and condylomata, of fungous and unhealthy granulations, or the secreting surfaces of cysts. To produce any considerable effect, the solid salt requires to be rubbed pretty firmly over the part to be cauterised, the surface being previously moistened if dry.

Corrosive sublimate possesses moderate caustic power, but is rarely selected for

this purpose. It is dangerous from the liability of absorption of the poison. *Tannic acid* and *alumen exsiccatum* are rarely employed.

FLUID.—*Nitric*, *hydrochloric* and *sulphuric* acid, in a concentrated form, are the most powerful of the potential cauteries; their influence extends rapidly through the common integument of the body to the deeper textures; they will act upon any part of the surface to which they may be applied. In the liquid form no caustic is so suitable as one or other of the above named for destroying the surface of sloughing sores, or for the local treatment of hospital gangrene. Their effect on such a surface is decided, rapid, and in the case of the monohydrated nitric acid, far less painful than is generally supposed: the resulting eschar separates quickly, and the surrounding inflammation is not excessive. In applying the strong acid to a sore, the surface of the part should be carefully dried, and the skin in the neighbourhood protected by being smeared with oil or simple cerate; and a glass brush or a piece of cotton-wool or lint, tied on the end of a piece of wood, may be used to bring the acid in contact with the surface of the sore.

For application to the sound skin, the concentrated acids are somewhat too diffuse in their action: with a view to obviate this tendency, they are mixed with various inert substances, and made into the consistence of a paste; thus sulphuric acid is mixed with powdered sulphur, saffron, or sawdust, and in this form it is far more convenient and manageable for the purpose above mentioned. The use of sawdust for this purpose originated with Mr. Syme, who also devised a most ingenious plan for protecting the surrounding surface, a method that can be adopted with great advantage whenever caustic is applied to the unbroken skin. For the purpose of destroying phagedænic chancres, M. Ricord employed sulphuric acid made into a paste with charcoal. Mr. Syme's method consists of protecting the surrounding skin by covering it for some distance with a thick piece of gutta-percha having a central aperture corresponding to the surface to be destroyed, and attaching it by a solution of gutta-percha in chloroform, then building up a wall of gutta-percha and lint around the edge of the opening, and finally applying the mixture of sulphuric acid and sawdust of a consistency of thin porridge. In the course of ten or twelve hours a slough will have formed, presenting the 'appearance of strongly compressed tow.'

Acid nitrate of mercury.—Owes its activity to the nitric acid in its composition; though less powerfully caustic than that acid, it is better fitted for application to certain parts, since it does not fume when exposed to the air. It is much in use for the destruction of lupous and rodent ulcers and acne tubercles, and for the first of these it is a most convenient and efficacious application. The solution is best applied with a camel's-hair brush, the surface of the part being previously cleansed and dried: it is necessary to limit carefully the application to the diseased part, since the epithelial covering of the mucous or cutaneous surface affords an insufficient protection against the action of this caustic. It may be well to mention that cases of poisoning are recorded from the absorption of this substance applied as a caustic.

Terchloride of antimony, or butter of antimony as it is usually termed, is a substance possessing powerful caustic properties, though but little used in this country at the present day, and consists of a solution of the terchloride of the salt in hydrochloric acid; it is used for the destruction of syphilitic warts or condylomatous growths, and is recommended by Continental surgeons for application to poisoned wounds and the bites of rabid animals. The solution may be applied with a camel's-hair brush until a whitish slough is produced, when the surface of the part should be thoroughly washed to remove any remaining caustic.

Bromine has been employed to destroy the chancres, and also in the form of injection, into epithelial cancers affecting the cervix uteri, in the strength of twelve minims to a drachm of rectified spirit.

Cautérisation en flèches.—In 1858 M. Maisonneuve drew the attention of the Académie des Sciences to a method of applying caustic for the destruction or enucleation of solid growths, and gave to his method the name at the heading of this paragraph. The caustic he employs for this purpose is a mixture of one part of

chloride of zinc and three of flour, combined so as to form a thick paste. This being spread out into a flat cake, is cut into narrow lancet-shaped strips, or wedge-shaped pieces, of a suitable size; these are subsequently dried until they acquire sufficient consistence to be available for the purpose about to be described.

One plan of attacking a solid growth with this form of caustic is the following: the base of the tumour is surrounded at short intervals by radiating punctures, converging towards the centre and deepest part of the growth, and completely undermining the diseased tissues; these punctures are made with a double-edged scalpel, the flat of the blade being turned towards the surface of the surrounding skin, and each should be of sufficient size to admit of the introduction of one of the caustic arrows previously prepared; as each puncture is made, the caustic should be at once plunged into the track of the knife, and allowed to remain. In a period varying from ten to twenty days, the whole growth will generally separate, leaving a clean granulating wound.

In cases where the growth cannot be circumscribed in the manner above mentioned, but can only be approached from the surface, M. Maisonneuve plunges the 'flèches' in parallel lines into all parts of the substance of the tumour; or again, when it is important to preserve the skin over the site of a tumour, one or more of the 'flèches' may be introduced through a lateral puncture quite into the centre of the growth, the resulting slough being allowed to escape through the aperture of puncture.

As a more convenient and more ready form of caustic, Sir J. Paget has made use of small lancet-shaped slips of wood dipped in fused chloride of zinc; these are more readily prepared, and far more easily introduced, than the flèches recommended by M. Maisonneuve.

The galvanic cautery.—This country is indebted to Mr. Marshall for the application of this most commodious and ingenious form of cautery, the use of which was so perfected and generalised by Middeldorpf that it has since undergone but little alteration or modification. The principle of its action is based on the fact that the passage of an electric current through any body will, under certain conditions, elevate its temperature in proportion to the resistance it offers to the passage of the current, and to the electrical intensity of the latter. This resistance varies according to the nature and diameter of the substance, whilst the intensity of the current depends upon the size and number of elements in the battery. Platinum is an indifferent conductor, and if a thin piece of wire of this substance be inserted in the circuit so as to connect the ends of two copper wires proceeding from a galvanic battery, the resistance thus interposed will, if the battery be sufficiently powerful, raise the wire to a state of incandescence, and even fuse it. Any badly-conducting substance will act in a similar manner, but platinum is that best adapted for the purposes of the surgeon, from the high temperature necessary to fuse it. The essential requirements of a galvano-cautery are therefore a powerful galvanic battery and a platinum wire of the requisite length, thickness, and shape. In order to obtain the greatest calorific effect, the battery should be composed of a few cells with a large acting surface, thus reducing its resistance to a minimum; and the two most usually selected for the purpose are the nitric acid and the bichromate batteries. Middeldorpf preferred four large cells of Grove's nitric-acid battery with zinc and platinum elements; but this is costly and bulky, easily enters into ebullition, and gives off whilst in action irritating fumes of nitrous acid. In place of zinc and platinum, v. Bruns employed zinc and iron, and Stohrer zinc and carbon elements; but in all these the irritating fumes yielded by the nitric acid are objectionable. The bichromate battery consists of zinc-carbon pairs in an acid solution of the bichromate of potash, so arranged that the battery can at once be brought into action by lowering and immersing the plates in the fluid. During the chemical decomposition which occurs in the working of this battery, hydrogen is set free, arrested on the carbon, and leads to the polarization and diminution of the electrical current. This unsatisfactory occurrence can only be prevented by blowing in air by means of a bellows or by agitating the fluid to get rid of the hydrogen, and is liable to occur quite suddenly, thus rendering the

action of the battery extremely uncertain. Between the battery and the cautery instrument the conducting wires should be composed of copper, well insulated, of sufficient thickness to interpose no resistance, and sufficient flexibility to permit an easy and unimpeded use of the cautery. According to the shape and arrangement of the platinum loop, the special instrument may serve as a cautery knife, trocar, or *écraseur*. The galvanic cautery or knife consists of a handle of wood about five inches in length, from which two isolated copper wires project about an inch at one end, where they are attached to the conducting wires of the battery, and about two and a half inches at the other, where they terminate in the platinum wire loop. One of the copper wires in the handle is interrupted in such a manner that its ends can be approximated or separated, and the current thereby made or broken by means of a sliding knob affixed to the handle. The platinum loops vary in thickness, length, and shape, according to the object and locality of the application of the cautery. Its free portion is from one to two inches in length, is either round and of uniform diameter throughout, or flattened and broad at the curvature of the loop, with both limbs parallel to each other, or converging to a narrow point, or bent at an angle upon itself. When a broad cauterising surface is required, the platinum is wound in a spiral manner around a porcelain cone, which is fitted to the extremity of the instrument. The *écraseur* is a noose of fine platinum whose ends are affixed to the apparatus by which the loop is gradually constricted until it is finally closed.

After the battery has been prepared for use, it is placed at a convenient distance, behind or on one side of the operator, if necessary under the supervision and control of an assistant, and connection then made with the instrument about to be employed. The simplest of these operations is the use of the cautery for the destruction of lupoid, epitheliomatous, or other new growths on the surface of the body. The circuit being established by means of the sliding knob attached to the handle, and the platinum wire raised to a bright red heat, it is brought into contact with and pressed upon the part to be destroyed; as it cools or becomes covered with shreds of the cauterised tissue, it is momentarily removed whilst the adherent mass is wiped off or burnt away by the heated platinum, and then, as soon as it glows again, reapplied to the same or another spot. This is continued until the whole of the diseased structure has been destroyed. Should hæmorrhage from a limited point accompany its application, the pressure of the wire will suffice for its restraint; but if it well up in larger quantity, it is necessary to secure its cessation by pressure before the cauterisation is resumed. In treating fistulæ by this method, a fine, narrow, beaked platinum wire is selected, introduced cold, and rendered incandescent when in position; and after the surface has been thoroughly cauterised, the current is interrupted and the wire withdrawn. When the cautery is employed as a knife, the sharp angle of the flattened platinum loop is pressed lightly against the skin at the spot of the required incision until the cutaneous tissues are penetrated; if the platinum cools, it may be withdrawn for a moment and then reinserted, and the incision prolonged, in this manner, until the necessary length and depth is attained. The adaptation of the *écraseur* depends upon the size, position, and form of the part which is to be embraced. When this is superficial, of moderate size, and pedunculated, the loop of platinum is passed over the summit and drawn tightly around the neck; but if its size or shape be such as not to permit this, one end of the wire, being left free, is passed around the base of the growth, and then conducted through the tube of the *écraseur* and fixed. Occasionally the growth springs from so broad a base that the loop fails to maintain a secure hold, and the wire is then passed through the base by means of a trocar and cannula. Similarly in the case of fistulæ and ulcers which are to be divided by the platinum loop, the wire is passed along the track of the fistula by a needle or trocar. After the wire has been fixed in position so as to constrict the part which it encircles, the instrument is connected with the conducting wires of the battery, and the wire slowly and gradually tightened until it has completely cut its way through.

The cautery in question possesses its chief superiority over the more usual form

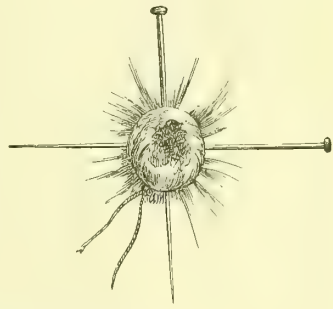
of actual cautery in the greater and easily regulated intensity and the duration of the temperature employed ; but, although the intensity of its heat is superior, its extent of action is less widely diffused, thereby diminishing the risk of injury to the neighbouring parts, but lessening its hæmostatic property. In addition to the facility with which its mechanical form can be suited to the external circumstances and other requirements of various parts of the body, one great advantage which it possesses, even over the thermo-cautery, is the possibility of introducing it in an inactive condition, and raising it to the requisite temperature after its proper adjustment to the parts to be cauterised, a property which is of especial value when its service is required in the various cavities and canals of the body. Its hæmostatic power is of the most variable degree, according to the conditions and circumstances under which it is employed, being influenced in great measure by the degree of heat, the rapidity of its action, and the amount of compression employed. When applied at a white heat, so as to speedily divide vascular tissue, hæmorrhage is not infrequent, but the probability of its occurrence is lessened when the temperature of the wire is confined to a red heat, and it is worked deliberately. The action of the ligature differs from the cautery in this respect, for by the constriction of the former the vessels are partially emptied or become blocked with thrombi, and hæmorrhage is less likely to ensue. Its disadvantages are the costliness and complexity of the apparatus, the expenditure of time and trouble in its preparation, and the not infrequent uncertainty of its action.

The thermo-cautery, an invention of M. Paquelin, obtains its heat from the combustion of certain hydrocarbons, and its construction is based on the principle that platinum, or similar metals, when once raised to a certain degree of heat, becomes incandescent when brought into contact with a gaseous mixture of air and certain hydrocarbon vapours, and remains so as long as it is in contact with this mixture. The advantages which are claimed for it are, that it can be made to assume any form of knife or cautery, it becomes instantaneously incandescent, and continues working for lengthened periods at any definite temperature ; that its heat can be immediately intensified or abated, and that it traverses the tissues without its action being sensibly diminished. It consists of three parts : a focus of combustion, a recipient for the volatile hydrocarbons, and an india-rubber air-ball. The first constitutes the cautery so-called, and consists essentially of a hollow chamber of platinum of large surface, which is shaped according to the requirements of the cautery. Added to this are two concentric tubes : an outer, soldered to the platinum by one of its extremities, serves to remove the products of combustion which escape from an orifice at the other end ; and an inner, which passes through the former to be fixed to a wooden handle, and conveys the gaseous mixture into the interior of the platinum. The recipient is a glass bottle containing benzoline, and fitted with an india-rubber stopper having two metallic tubes through its centre, one of which brings air from the india-rubber ball, and the other conveys it saturated with hydrocarbons to the cautery. All the three parts are united by india-rubber tubing with thick walls. When the cautery is about to be used, its platinum end is heated for twenty or thirty seconds in the flame of a spirit-lamp, and then with a few strokes of the india-rubber ball it becomes rapidly incandescent. The air thus driven in passing through the flask is charged with the hydrocarbon vapour, and becomes ignited by the heated metal. It burns without flame, and forms a source of heat within the platinum which rapidly raises it to the requisite temperature, which is maintained by its own heat so long as the insufflation is continued. Certain precautions are necessary to be observed in the working of this cautery in order to prevent any interference with its action. After each application it should be allowed to cool slowly, and carefully dried to get rid of any moisture, blood, charred materials, &c. The platinum must be heated sufficiently to determine the combustion of the gases, and the insufflation performed slowly ; the temperature of the hydrocarbons should not be too high or too low ; and to enable the air to reach the flask in sufficient quantity, this should not be more than half-filled.

STRANGULATION OF NÆVI AND OTHER TUMOURS.

Nævi and some other small tumours may be strangulated by external or by subcutaneous ligatures. The most simple form of external ligature, and such as is well suited for small growths that are partly cutaneous and partly subcutaneous in their origin, consists in passing beneath the growth two fine harelip-pins at right angles to each other. These should enter the skin clear of the nævous structure, and passing completely beneath its base, should emerge through the sound skin beyond; a piece of strong twine being wound around beneath the needle-ends, the growth may be strangulated and the whole secured by a double knot (fig. 122). For convenience, the needle-ends may be shortened, and a strip of lint may be wound beneath them to protect the surrounding skin, the whole being left to come away by sloughing. By some the needles are made use of only to raise the nævus during the tightening of the ligature, being withdrawn just before the knot is tied.

FIG. 122.



Again, a good plan, and efficacious for small nævi, recommended by Mr. Cooper Forster, is to tie the nævus upon the pins, withdraw them, and four or five hours afterwards to cut or untie the ligature. The crushing which the nævus or its vessels of supply undergo in this process leads to the wasting and shrivelling up of the growth, which separates in two or three weeks in the form of a dry, scabby lump; the resulting cicatrix is less considerable than that left by the ordinary plan of external ligature.

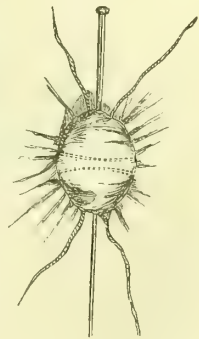
To lessen the pain of the ligature, and to hasten the separation of the slough, it is advisable to trace with the point of a small knife a groove in the skin in which the ligature may lie; this incision should run around the base of the nævus, connecting one needle-puncture with another. Some nævi, though of considerable size, are covered with sound skin, or a disproportionately small extent of this is affected. In strangulating such, before passing the ligature around the pins, a crucial incision may be made over the surface of the growth down to its base at the points where the pins pierce the integument; the four included flaps being reflected, the ligature is applied within them, so that after the separation of the slough they may, in part at least, cover the denuded surface. It is probable, however, that nævi situated at such a depth beneath the surface, and with the integuments so little affected as to admit of this proceeding being adopted, would be more suitably treated by injection or complete excision.

FIG. 123.

Subcutaneous ligature.—For the convenience of description, under this term all such ligatures will be described as are passed subcutaneously, either around the nævus or beneath it, whether completely or only partially beneath the skin.

The partially subcutaneous ligature, which is ordinarily in use for mixed nævi of large size, may be so arranged as to strangulate the growth (*a*) in halves, (*b*) in quarters, or (*c*) in as many portions as its size or shape may require.

(*a*) For strangulating a nævus in halves, a strong stout needle, or one fixed in a handle with an eye at the point, being armed with a double thread, may be passed beneath the growth, so as to be quite clear of the nævous structure. The looped end of the twine being cut, the four ends may be grasped and used to raise the growth, while a pin is passed beneath it at right angles to the track of the ligature. The opposite ends of each portion of the ligature may now be tied together firmly beneath the end of the pin on the same side; the latter being shortened to a convenient length, the growth may be allowed to separate by slough-



ing (fig. 123), or the pin may merely be used to raise the nœvus upon during the tightening of the knot, and be subsequently withdrawn. It is advisable to divide the skin around the nœvus in the track of the ligature, just before drawing the latter tight.

For carrying ligatures beneath nœvi, besides the common needle (fig. 124a) and that which has an eye opening and closing at will, shown in fig. 124b and fig. 125, there is a convenient needle, with a slit in the side of the eye, closing with a spring, from which the thread can be disengaged by simply pulling on the loop (fig. 124c).

(b) Of the plans in use for tying nœvi in quarters, there are two of almost equal efficiency; the one introduced by Sir W. Fergusson, the other recommended by Mr. Cooper Forster. The latter gentleman uses a needle with an eye near the point, which opens at will, so as to disengage the thread by pushing a button attached to the handle (fig. 125). The needle being thrust beneath the centre of the nœvus, and out at the opposite side, the eye is opened, and the loop of a long and strong piece of twine is introduced, and retained by closing the slit in the side of the needle,

FIG. 124.



which is withdrawn, bringing with it the double ligature, one end of which is divided, and the other, being carried a quarter of the way round the nœvus, is thrust with the needle beneath the growth at right angles to its former course.

FIG. 125.¹

This thread is now detached, and one end of the other thread is passed into the needle's eye and withdrawn with it beneath the nœvus; the skin being divided to receive the ligature between the points of perforation, the four ends of the ligature may be tied together two and two.

Sir W. Fergusson makes use of a strong curved suture-needle, having a large eye. This being threaded on the middle of a long and strong piece of twine is passed beneath the nœvus, the double thread being drawn half its length out on the opposite side; the loop is now divided on one side of the eye of the needle, and the opposite end of the thread that was cut is passed into the eye. These two ends are then carried with the needle beneath the nœvus at right angles to the former course of the thread; the four free ends can then be tied two and two, the skin having been divided in the track of the ligature (fig. 126).

(c) The shape and size of a nœvus, or the external conformation of the part upon which it is situated, may be such that the above-described ligatures are unsuitable for effecting its strangulation; for such cases, especially where the growth is of oblong form, a thread may be passed beneath the growth at suitable intervals, and the included portions be separately tied up. For this purpose, a large curved suture-needle may be threaded on the middle of a long piece of twine, one half of which has been previously dipped in ink, or otherwise coloured. The needle may be passed beneath the growth at right angles to the long axis of this, at suitable intervals backwards and forwards until the whole disease has been included between the threads. All the black loops of the twine on one side being cut, and all the white loops on the opposite side, each pair of white ends may be tied together on the one side, and on the opposite each pair of black ends (fig. 127). If it be thought necessary, hare-lip pins may be used in conjunction with this suture; being passed at right angles to the course of the thread, they may be used either to raise the growth during the tightening of the knots, or they may be left in situ until sloughing takes place, to insure that the ligature, in cutting its way through, shall pass completely beneath the disease.

Completely subcutaneous ligatures, when applied for the strangulation of vascular

¹ The eye of the needle is here shown open.

tumours, may be so arranged as to include the growth in (a) a single loop, or (b) in two portions.

(a) To strangulate a nævus with a subcutaneous ligature in a single loop, a strong curved needle carrying a stout ligature is passed into the cellular tissue, close

FIG. 126.

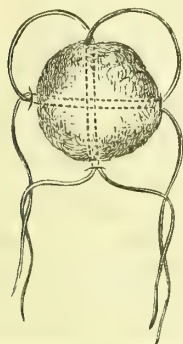


FIG. 127.



to the nævus, and carried around the circumference of the disease as far as the needle will conveniently reach (of course the concave side of the curve of the needle should be turned towards the nævus in effecting this); the needle-point may then be protruded, and the ligature and needle drawn out, to be again introduced at the same hole, and carried onwards in the same direction, until the whole nævus has been surrounded, the needle being at last brought out at the point where it first pierced the skin (fig. 128).

(b) To produce strangulation of a large nævus, it may be necessary to tie up each half separately; to effect this with a subcutaneous ligature, a double thread being

FIG. 128.

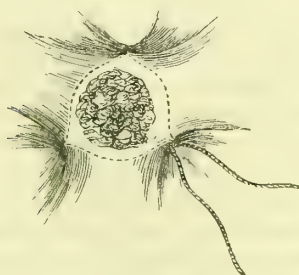
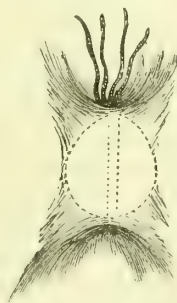


FIG. 129.



carried beneath the base of the growth, the loop on one side of the eye of the needle may be divided, and each end of the thread be carried separately back beneath the skin, round the opposite semi-circumferences of the growth; the needle being introduced at the former point of exit, and emerging where it first pierced the skin. The opposite ends of the same threads being tied together, the two halves of the nævus will be separately strangulated (fig. 129).

THOMAS SMITH, 1871.

ROBERT LYELL, 1882.

PLASTIC SURGERY.

PLASTIC SURGERY is the art by which all those deformities which result from the congenital deficiency or artificial destruction of parts, or from the abnormal contraction or closure of a natural opening, are rectified, and comprehends a multiplicity of operations, which have one feature in common, the union of artificially refreshed or divided surfaces. When the tissue by which the defect is repaired is derived from the same individual, the fact is expressed by the word *autoplasty*, in contradistinction to *heteroplasty*, which serves to indicate its derivation from a separate individual. Tagliacotius was the first to employ a general term, '*Chirurgia curtorum per insitionem*,' for this department of operative surgery, and this remained unreplaced until the revival of the art at the beginning of the present century, when Graefe initiated a new nomenclature by constructing a distinctive term, *Rhinoplasty*, for the restoration of the nose. Others, as *Cheilo-*, *Blepharo-plasty*, were quickly added, and as these separate operations and titles multiplied, a necessity for some general comprehensive term was experienced and supplied by each author on the subject until a most exuberant nomenclature existed, including such titles as *Morioplasty*, *Transplantatio*, *Ente animale*, *Organoplasty*, &c. All these have long been disused and replaced by that of *Plastic Surgery*, first employed by Zeis about the year 1836.

Its practice dates from early times both in the Eastern and Western continents. In the Western the first recorded reference is to be found in Celsus, who describes a means of closing a quadrilateral defect by the aid of direct and lateral incisions; but there exists no mention of actual performance until the early part of the fifteenth century, when the operation of restoring the nose from the arm and face was practised by Branca, a physician of Sicily, and his son. On the death of the latter the art crossed from Sicily into Calabria, where it was preserved for three generations in the hands of the Vianco family. It is probable that little or no interval intervened between these attempts and the practice of one whose name is imperishably associated with the history of rhinoplastic surgery, Gasparo Tagliacozzi, whose success in this direction, however, found but few imitators, and at the end of the eighteenth century appears to have been either entirely forgotten or altogether discredited. At the close of this century interest in the operation was revived by the publication in the '*Madras Gazette*' of 1794 of an account of a rhinoplastic operation performed in India by means of a flap of skin cut from the forehead. From subsequent information it appeared that the practice of restoring the nose in this manner had been known in India during many centuries, that it was confined to a certain class of priests, the *Koomas*, and that a description of the method was contained in the earliest compilation of medicine extant, the *Suséntás Ayurveda*. After its introduction into Europe, Lynn was the first to attempt its performance, although unsuccessfully, in 1813, and was followed by Carpie, who published an account of two successful cases in 1814, and by Graefe in Berlin, who in 1818 resuscitated and modified the Tagliacotian operation, and in the following year performed a successful rhinoplasty. This period represents the revival of the plastic art, which has since steadily progressed to its present state of development.

The power of reproducing parts that have been destroyed is very remarkable in many of the lower animals, as, for example, the re-formation of the tail of the salamander, the claw of the crab, the entire body in polyps, the antennæ of insects; but in man this property is of much more limited scope—in fact, the higher the animal in the scale of development, the weaker appears to be this creative or repro-

ductive force. Man is only capable of regenerating his simple tissues, and more particularly the epithelium, nails, and hair. The regeneration of bone is, however, a well-recognised and familiar fact; newly-formed muscular fibres have been detected with the microscope, and the clinical experience of nerve injuries points to the restoration of nerve-fibres; but this property is not extended to the higher and more complex structures, and it may even be doubted whether any of the tissues, even the lowest, when replaced, exhibit exactly the same characters they presented before.

'In 1858,' says Mr. Holmes Coote,¹ 'I had the opportunity of examining two Achilles tendons, which had been subcutaneously divided at periods of two and three months previous to the death of the patient; and it was there seen, after making a longitudinal incision, that the divided ends of the normal tendo Achillis, two inches apart, were united by a light grey semi-transparent structure, quite different from natural tendon, and readily distinguishable to its very boundary.'

Nature is thus, in great measure, unequal to the task of restoring partially or wholly destroyed parts, and its insufficient creative force requires to be supplemented by the art of the surgeon, who, availing himself of the readiness with which living parts adhere together, effects a restoration by transferring or substituting another part or tissue for that destroyed. A large amount of experimental evidence conducted on man and the lower animals attests the practicability of such a procedure. The experiments of Duhamel, Baronio, and Hunter, of transplanting the spur of a cock to the comb, and transferring the testicle of the cock to the peritoneal cavity of the hen, are historical facts. Dieffenbach transplanted the quills of birds, and found them unite if suppuration were prevented; but with hairs he was less successful, although Dzondi is reported to have implanted lashes in a newly-constructed eyelid. That teeth, if replaced after extraction, will recontract adhesion and become firm, is a fact conclusively shown by Hunter and Mitscherlich; and the existence of a vascular connection seven weeks after such a reimplantation was actually demonstrated by Wiesmann; whilst quite recently M. Magitôt is said to have failed only five times out of sixty-three such attempts at reimplantation. Ollier succeeded in 1858 in transplanting completely separated portions of periosteum in the lower animals; but similar attempts in man have invariably ended in failure. The same experimenter has also obtained successes with osseous tissue in animals, transferring portions of the radius in the rabbit from one side to the other, but, as with the periosteum, the results when applied to man cannot be considered otherwise than unsatisfactory. Walker speaks of the reunion of a piece of a trephined bone, and Macewen transplanted a portion of the canine to fill a defect in the human skull; but Percy failed to obtain union with a piece of tibia of the ox in a case of compound fracture in man. Quite recently Dr. Macewen² has effected a most striking restoration of the entire diaphysis of the humerus, by transplanting into the gap at successive operations, and with strict antiseptic precautions, the wedges of bone removed from tibiæ affected with anterior curvatures, and divided into small portions before insertion. Of interest, also, are the experiments of Glück³ on the transplantation of portions of nerve, tendon, and muscle in the lower animals. He has succeeded in implanting a portion of nerve of one animal to fill a gap an inch and a quarter long in the nerve of another, and restoring its conducting property; and also in transplanting a considerable portion of the gastrocnemius and tendo Achillis from one fowl to another. It is, however, in vascular parts, as the skin, that adhesion under such circumstances is most frequently seen. Bunger relates a case of partial success in the formation of a new nose on a lady by a piece of integument completely cut away from the thigh; and Hoffacher, who was officially appointed to attend at the duels frequent among the students at Heidelberg, mentions some remarkable instances, which are attested by Chelius and Velpeau, of the reunion of parts completely sliced off by sword-cuts; e.g. portions of the nose, lips, or chin. Martin⁴ has collected twenty-seven cases in which the nose,

¹ *Med. Times and Gaz.* Jan. 9, 1858.

² *Proceedings of the Royal Society*, vol. xxxii. 1881, p. 240.

³ *Archiv f. klin. Chir.* 1880, Bd. xxv. S. 607 and Bd. xxvi. 1881, S. 61.

⁴ *De la durée de la vitalité des Tissus*, 1873.

and Berenger-Feraud¹ thirty-four in which the finger, was successfully replanted, after being completely detached. Separated portions of skin of considerable size have also served for the cure of ectropion in several instances, forty of which have been tabulated by Monod,² of which twenty-four were successful. This form of transplantation of entirely detached parts is more correctly designated grafting, and its application in true plastic surgery is limited, owing to the precarious vitality of the borrowed part. The latter should rather retain its vascular relation with the rest of the body by means of a connection sufficiently broad to permit a free circulation through it, and to preserve its vitality until adhesion is complete. Inasmuch as most defects which require surgical interference are superficial, their closure is in the majority of cases effected through the medium of the skin or mucous membrane, with or without the periosteum, and in the form of a recent flap. Granulating flaps are, however, preferred in exceptional instances by some operators, and have been used by Billroth and Thiersch in cases of extroversion of the bladder, and by Czerny for the healing of obstinate ulcers about the lower extremities. Other tissues have been selected in special instances. Nussbaum³ accomplished the cure of an ununited fracture of the ulna by transplanting a flap of bone, comprising half the thickness of the upper fragment, into the gap, by means of the chisel and saw; and Létréaut⁴ describes a similar autoplasmic procedure, by means of a nerve flap, in defects implicating large nerves which are impossible to unite by simple suture.

All operative procedures of plastic surgery are based upon two broad general principles: the mobility of the skin and soft tissues permitting their transference from one site to another, and their readiness to unite in their new position and become incorporated with the surrounding tissues. The mobilisation is effected by the instrumentality of the surgeon, who employs for this purpose certain auxiliary measures which have been classified by Denucé⁵ in the six following categories: (a) Traction, a measure which by itself is amply sufficient for the accomplishment of many important plastic operations, and which is limited only by the physical extensibility of the tissues and their anatomical relations; (b) Relaxation, acting partly by facilitating traction, and partly by diminishing the size of the defect; (c) Subcutaneous detachment, or freeing by the knife of the integument and cellular tissues from the subjacent parts, rendering available the utmost degree of the extensibility of the skin, and capable of being practised over a wide extent of surface; (d) Excision of triangular portions of tissue from the circumference of the defect, facilitating the gliding of its margins toward each other, or altering its shape; (e) Incisions of two kinds, either parallel to and at a distance from the defect, lateral or liberating; or at right angles to its margin, the direct, usually straight but occasionally curved, V or W shaped; (f) Transposition or transplantation of a flap to fit the defect, which is thus transposed to a part where its closure becomes more easy. The application of these measures, either singly or in combination, originates the so-called operative methods. It is readily seen that there exists a strong line of demarcation between the cases for which the first five measures suffice and those for which the last is necessary; for in the former, the edges of the cleft are brought into contact by gliding them towards each other, and in the latter they are united to those of a skin flap transferred from the neighbourhood; whence originate the two primary autoplasmic methods—that of gliding (*par glissement*), and that of transplantation. Simon,⁶ on the other hand, adopts the three following principal methods: (a) simple extension; (b) total displacement, either by subcutaneous detachment and incisions, or by a circumscribed flap; and (c) transplantation proper.

The method of gliding includes a very large number of operations, which have been systematised according to the shape of the defect to be covered and the auxiliary incisions employed for this purpose. The shape may be triangular, quadrilateral,

¹ *Gaz. des Hôpitaux*, 1870, p. 414.

² *Bull. et Mém. de la Soc. de Chir.* 1881, t. vii. p. 647.

³ *Centralblatt f. Chir.* 1875, No. 15.

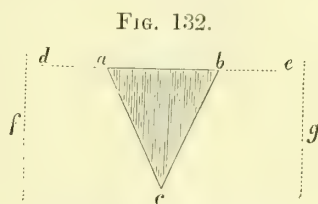
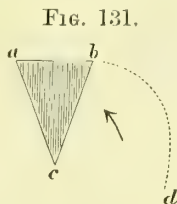
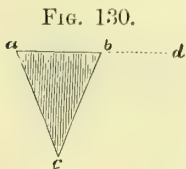
⁴ *Traité des Sections nerveuses*, 1873.

⁵ 'Sur l'Autoplastie,' *Archiv. gén. de Méd.* 1855, v^e sér. t. vi. p. 402.

⁶ *Prager Vierteljahrschrift*, 1866, Bd. 92, S. 1.

oval, round, or polygonal, and a number of groups are thus formed which comprehend all ordinary cases, and are illustrated by the following few examples.

Triangular defects, if small and equilateral, may be closed partially by the union of their angles, but if larger, require auxiliary incisions or the use of a flap; $a b c$ is the defect to be covered.



Figs. 130 and 131 represent unilateral, straight and curved (Jaesche) direct incisions ($b d$), $c b d$ being loosened and united to $a c$. Fig. 132, bilateral direct ($a d$ and $b c$) and lateral ($f g$) incisions (Celsus); $d a c$ and $e b c$ are united, leaving oval defects at f and g to heal by granulation.

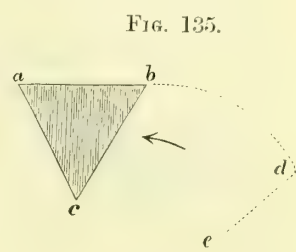
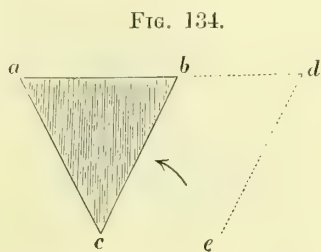
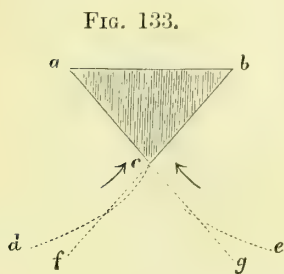
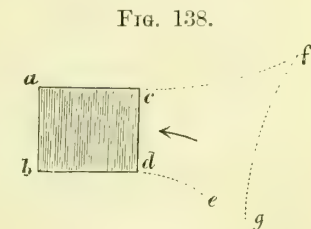
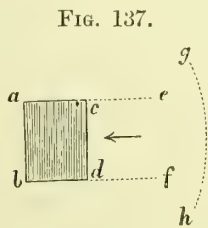
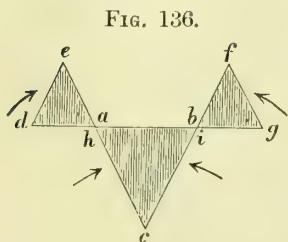


Fig. 133, bilateral direct straight ($c f$, $c g$) or curved ($c d$, $c e$) incisions, from the apex of the triangle $a b c$; the flaps $a c f$, $b c g$ are raised and united to $a b$.

Fig. 134, unilateral combined direct ($b d$) and lateral ($d e$) incisions (Dieffenbach), forming a quadrilateral flap, $c b d e$, which is displaced to $a c$; modified by Szymanowski by making $b d$ oblique and d more acute-angled.

Fig. 135, combination of the operations of Jaesche (fig. 131) and of Dieffenbach (fig. 134).

Fig. 136, method of Burow, by excision of one or two lateral triangles $e d h$ and $f i g$, the edges $e d h c$, $f g i c$, being dissected up to permit the union of $a c$ and $b c$, $a e$ and $e d$, $b f$ and $f g$.



Quadrilateral defects, when narrow and oblong, are closed by approximating the sides or the angles by sutures; if they are of large size, incisions are requisite.

Fig. 137, direct incisions $c e$, $d f$, with or without the addition of curved or angular liberating incision $g h$, the flap $e c d f$ being stretched over the defect, and $c d$ united to $a b$; if the defect be too large for a single flap, it may be covered in separate parts, as in fig. 139, the upper by two lateral and the lower by a single flap from below.

Fig. 138, combination of lateral incision $f g$ with direct, $c f$, $d e$, so as to form an acute angled quadrilateral flap.

Fig. 140, operation of Letenneur, by a flap $b e f g$, freed from below and raised till $e f$ is united with $a d$.

Fig. 141, operation of Bruns in trapezoidal defects, by two corresponding lateral flaps, *a e f g*, *b h i k*, brought down so as to unite *e f*, *h i*, in the median line.

FIG. 139.

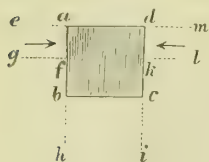


FIG. 140.

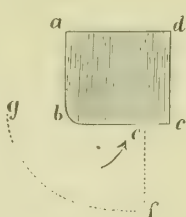
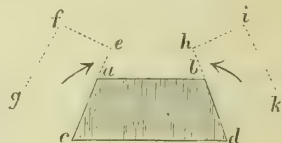


FIG. 141.



Oval or elliptical defects of moderate breadth are closed by simple approximation, or by the use of single or double lateral incisions, straight, curved or angular (fig. 142), or by direct incision from the centre of one margin of the ellipse, either by a single vertical or two curved incisions; or a combination of these last, as in fig. 143, *c d* vertical direct incision, from the end of which are two curved, *e d*, *d f*, forming the flaps *a c d e*, *b e d f*, which is raised and united to *a b*.

Fig. 144, operation of Weber, by crescentic flaps *a c d*, *b c f*, the apex *c* of flap *a c d* being raised to *b*, and the gap thus left being filled by *c e f*.

FIG. 142.

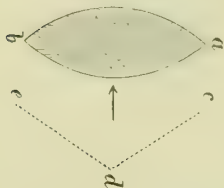


FIG. 143.

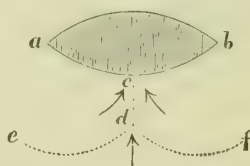
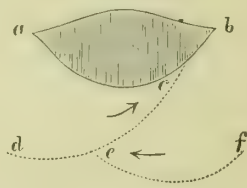


FIG. 144.



These few examples are capable of wide extension and multiplication, but are sufficient to show the general principles on which this method is based.

Flap transplantation comprehends the following principal and secondary methods. (a) Transplantation from the neighbourhood (the Indian operation) is distinguished from simple lateral displacement by the fact that the defect remaining from the transference of the flap is separated from the original, by intact structure of considerable or limited extent. The pedicle is either isolated from the defect by an intervening bridge of sound skin, and undergoes a process of twisting during the transplantation (method of torsion), or is continuous with it by the prolongation of one of its sides, which allows the flap to be rotated into position (method of rotation).

(b) Transplantation from a distant part (the Italian operation), such as the arm, forearm, hand, &c., is now but rarely applied. The flap is left attached to its original site until union is secure, when it is divided.

(c) Transplantation by reversed flap, so that its cuticular surface is directed inward and its raw surface outward, and a modification of this, superimposed or double flaps, in which the exposed surface of the former is covered in by a second transplanted over it. The most important among the secondary procedures are, the 'successive migration' of Roux, in which the flap is transferred from a distant part by stages, as in the restoration of the lip by a flap from the neck, which is first twisted transversely into a wound prepared for it, and as soon as union has occurred here, upwards to the lower jaw and thence to the lip; the 'rolling' of Velpeau, in which a flap is rolled up on its cutaneous surface, so as to form a plug to be inserted into a fistulous canal; 'reduplication,' and others of less frequency.

The execution of a plastic operation not only requires from the surgeon the correct adaptation of any particular method or operation, but, in order to conduct the case to a successful issue, the exercise of much patience and persistence in the face of possible failure, together with a rigid attention to all minute details. Few

cases present exactly the same features to the operator, who has to rely on his natural ingenuity, facility of resource, and previous experience to suggest the necessary incisions and frame the novel measures by which individual peculiarities are to be surmounted. For this purpose, each example has to be considered from its own standpoint, and the plan ultimately adopted for its relief carefully studied beforehand, taking into consideration the size and nature of the defect, the condition of the surrounding skin, the alterations in its elasticity, changes in its vascularity, and any existing individual idiosyncrasies; but, even the most careful precautions in this direction are not always sufficient to prevent the necessity of having to alter the projected plan, by reason of information obtained at the operation as to the extent and depth of the disease for which it is undertaken. When complicated and extensive operations are required, the risk of failure is undoubtedly lessened by not attempting to complete too much at one sitting, but to perform these in stages, so that the success of each part is ensured before the next is commenced. Another principle which should guide the operator is that of economising the tissues operated upon, and removing only that which is absolutely essential, as, for example, in extirpating growths from the face; if such structures as the mucous membrane of the cheek or the cartilaginous framework of the nose or lids are unaffected, their preservation will prove to be of the greatest value to the subsequent plastic operation.

Union by first intention is the element that contributes in greatest measure to success. It is true that the same end may be attained in the presence of suppuration and granulation, and that the latter method of union has been in rare cases the design of the surgeon; but it may fairly be concluded that, when primary union fails, the result, if not altogether negative, will generally fall short of that originally contemplated. The previous preparation of the patient is, therefore, of the utmost importance as a preliminary measure for placing him in the best condition to ensure that plasticity of the blood essential for the occurrence of primary union; and it is therefore expedient, before proceeding to operate, to improve the general nutrition, to remove any local disturbances, and to eradicate or palliate any existing dyscrasic disorders. Of all these, the syphilitic virus exerts the most baneful influence. Jobert¹ only succeeded in closing a fistula in a case of latent syphilis after several failures, and similar cases may be quoted, although Szymanowski² has seen one, after the operation of rhinoplasty, in which an outbreak of the syphilitic process destroyed a large part of the palate, but left the transplanted flap untouched. In struma, Dieffenbach occasionally ventured upon plastic operations, but usually avoided the attempt so long as evidence of its presence existed; whilst Blasius and others have obtained satisfactory results from excising the lupoid growth, and transplanting a flap immediately over the defect thus created—a proceeding which is regarded by Fritze as directly producing a favourable influence on the local exhibitions of the constitutional disorder. Local cancerous growths and rodent ulcers yield themselves most favourably to the plastic art, but the new theory entertained by Martinet de la Creuse, that its adoption prevents recurrence in these cases, is altogether unconfirmed.

The tissue usually selected for the flap is the skin, which should be natural and mobile, and detached with a thin layer of subcutaneous areolar tissue. Its utility in autoplasmic operations, when taken from different parts of the body, has been enunciated by Langenbeck³ from rich experience. According to this operator, the skin of the extremities, except that of the palm and sole, is not adapted for large defects by reason of its thinness, laxity, excessive retractility, greater venous and feeble capillary development; the skin of the back and abdomen is more fitted, the latter being dense and mobile, but possessing a thick fatty layer which is prone to inflammation; whilst the skin of the face possesses the highest value for plastic operations, and furnishes its most extensive applications. Crusaid⁴ has tabulated

¹ *Traité de Chir. plastique*, 1849, t. ii. p. 171.

² *Handbuch d. op. Chirurgie*, 1870, S. 147.

³ Vertraeghe, *Essai de Chir. plast. d'après les préceptes de Prof. Langenbeck*, 1856.

⁴ *Handb. d. Chir. Pitha-Billroth*, Bd. i.

the degree of extensibility of the skin in various parts of the body, and has found it greatest in the upper forearm, and absent in the soles and palms. Cicatricial skin may be utilised if the alteration be superficial and the part mobile, but must be absolutely rejected when it is adherent to the subjacent structures. Its vascular supply and distribution is of considerable importance, and in this matter remarkably opposite views have been enforced by different authorities. According to Langenbeck, immunity from gangrene is only secured when the pedicle of the flap conveys sufficiently large arterial branches, which split up and divide; whilst, on the other hand, Dieffenbach taught that most frequently over-distension of the flap with blood, rather than its absence, endangered the vitality of it, and therefore recommended the division of the arterial trunks in the flap, together with the application of cold and scarification. Such a practice fails to commend itself, and in some cases doubtless precipitates that which it is intended to avoid; therefore it is advisable so to adapt the flap that by its thickness, attachments, size, and disposition of its pedicle, the supply of arterial blood is ample and its circulation unimpeded.

The technical part of a plastic operation comprehends three steps: refreshing the margin of the defect, dissection of the flap, and the adaptation of the latter. Revivifying is now generally performed with a cutting instrument, the knife or scissors, although formerly other exceptional methods, such as cauterisation to induce granulations, and scarification or abrasion, were in vogue. Whichever instrument be selected, the whole of the epithelial covering of the margins or surfaces intended for adhesion must be effectually removed, and all diseased, suspicious, or prejudicial structures excised, by employing either vertical or sloped incisions, and if necessary by loosening the recent margins for about 3 mm. and everting them, so as to provide a more extensive surface for support and contact. In cutting the flap, its shape should be made to correspond with that of the gap which it is destined to fill. The oldest operators, Graefe and others, when engaged in the restoration of such organs as the nose, &c., bestowed much care in fashioning the flap; but this artistic refinement compromised success, and induced Dieffenbach to substitute a flap of much simpler form, which he subsequently moulded to the requisite shape by accessory operations after it had become adherent. This is inconvenient, from the prolongation of the term of treatment and the liability to further accidents, and therefore it is preferable to adapt the flap in shape to the defect, and at the same time to avoid too minute exactitude. It should not be cut too large, otherwise it tends to fall into folds which interfere with union, or too small, for this would necessitate a dangerous degree of traction to enable it to cover the defect; but on an average from one quarter to one-third larger than the latter. A moderate degree of stretching is often of service to prevent that extensive retraction to which the uncontrolled flap is prone. After being thus designed, the flap is carefully dissected up from the subjacent textures, as far as its attached portion or pedicle, the breadth of which should depend upon the vascularity of the part in which it is situated, and according to Langenbeck should never be less than four lines. Generally a single flap is sufficient, but in certain cases, either from the size of the defect or for some special service, as supporting or covering in one flap, two or more become necessary. Accurate adjustment of the contiguous margins of the flap and defect is the final step, and is accomplished by the aid of sutures of the interrupted, twisted, or quilled variety. The closeness of their insertion varies according to the depth and breadth of the flap, and should be such as to prevent both constriction and gaping. Langenbeck frequently removes them at the end of sixteen or eighteen hours, but they may be left at the discretion of the operator for several days, or may be reintroduced if they fail to secure immediate union. According to Fritze and Reich, immediately after the flap, with the exception of the pedicle, has been separated from its connection, it becomes blanched and white, and then shrivelled or shrunken, with its edges curled inward. When the hæmorrhage has ceased, it acquires a bluish or marbled aspect, and falls in temperature; but after fixation the redness and warmth return, and hæmorrhage may recommence. During the subsequent few hours considerable changes appear in the circulation of the flap, which becomes sometimes paler, sometimes


redder, until, as the amount of blood increases, it assumes a red, warm, and swollen, or even a tense, shining, and inflamed appearance. If this congestion augment, the colour deepens to a blue or violet tinge, and gangrene threatens to ensue; but when the circulation becomes securely established and equalised, the abnormal swelling and colour subside, the skin of the flap assumes a natural appearance, and loses its superficial epidermal layer, which peels off. After adhesion has fully taken place later changes ensue in the flap. It may slowly shrink and atrophy, so as to be almost absorbed, or reduced to one-half or one-third of its original size, or become displaced, as in the subsidence of a new nose after division of its pedicle, or may undergo a form of hypertrophy. The sensibility of the flap which is at first destroyed begins to return in the pedicle, and after reappearing in the body of the flap, is for a time referred to the spot from which this is derived before it finally becomes normal. Jobert could not trace the branches of the nerves beyond the cicatrix, but their presence in the flap has recently been demonstrated by Busch.

Among the complications which endanger the existence of the flap, and cause failure, the chief are hæmorrhage, suppuration, and gangrene. Hæmorrhage is an evil in all stages of plastic surgery, whether the effusion be primary or secondary, and the adjustment of the flap should be delayed until this is perfectly controlled. It may recur some hours after the operation from the deep surface of the flap, as in a case referred to by Vidal-Bardeleben, in which it became necessary to remove all the sutures three hours after insertion and ligature several vessels. Gangrene appears about the third or fourth day. If the flap retains its vitality beyond this time, union generally proceeds without interruption. The parts assume a greyish colour when mortified, look soft and pulpy, and the cuticle loosens; or the flap may become dry, shrivelled, and withered. But even under these circumstances let not the surgeon remove it; for he cannot tell either how far or how deep the loss of vitality may extend. The edges of the wound alone may die, or the superficial parts may be thrown off; but in either case the surgeon should abstain from frequent examination, for a few days will reveal to him how much nature has been enabled to effect, and the extent and depth of the gangrenous process. Inflammation of an erysipelatous type may also attack the wound and prevent its union; and every precaution should be taken to prevent this, by improving the health and general condition of the patient, by the use of light and cleanly dressing, and by improved hygienic surroundings.

Plastic Operations on the Nose (Rhino-plasty).

Rhinoplastic operations are most commonly required to repair defects produced by the ravages of lupus, syphilis, or cancer, or resulting from traumatic influences, and but rarely for congenital malformations. They are designated total or partial according as the restoration involves the whole of the bony or cartilaginous nose, or is restricted to such limited parts as the alæ, columna, or apex; and whilst correcting a repulsive deformity, have an ultimate beneficial influence on the functions of both the restored and neighbouring organs, resuscitating in some cases the sense of smell, improving taste and hearing, and diminishing the existing tendency to bronchial catarrh. The requisite flaps may be obtained from the arm (Tagliacotian or Italian method), from the forehead (Indian method), or from the cheeks (so-called French method).

The Italian operation, as performed by Tagliacotius, may be regarded as obsolete, although it has been practised in a modified form in quite recent times. It comprised six stages, occupied several months in its performance, and consisted of cutting a flap of skin, six inches by four, from the arm over the biceps muscle, leaving it attached by its extremities, and allowing it to granulate upon a piece of oiled lint passed beneath it. At the end of a fortnight its upper extremity was divided and the flap left free to retract and cicatrise. Remaining attached at one end, it underwent a process of thickening and contraction, the stages of which were fancifully compared by Tagliacotius to the different periods of life of the individual. As soon as this was

complete, the margins of the flap and the nasal aperture were refreshed, the arm approximated to the face, and the flap secured to the nose by sutures, and its immobility assured by encasing the head and trunk in a special form of leathern jacket, to the head-piece of which the forearm was fixed. The ligatures were removed from the third to the fifth day, and on the twentieth, the arm-straps being loosened, the flap was separated from the arm, and the operation finally completed by fashioning the columna and alæ. After a long period of oblivion this operation was resuscitated at the beginning of the present century by Graefe, who compressed the three first steps into one act, in order to lessen the excessive shrinking of the Tagliacotian flap, and designated the altered procedure as the German method. The close contiguity to the cavities of the nose and mouth of a suppurating flap was obviously a disadvantage, and Dieffenbach (who was the first to employ the method for total rhinoplasty) rejected it, and reverted to the ancient method, endeavouring to prevent the objectionable shrinking by folding the flap upon itself in the following manner:—The incisions are made diverging, and after subcutaneously freeing the bridge flap, the outline of one alæ is cut from its broad lower end by carrying a short horizontal incision about a third through the base of the flap, and from the end of this a shorter longitudinal one, thus . This corner is then drawn underneath the flap until the latter is reversed, and its margins are then stitched together along their whole length. When the wound is cicatrised, the flap is detached at the upper part; split down the recent edge of union, and sutured to the refreshed stump of the nose, and the operation completed according to the Tagliacotian method. In order to avoid the irksome position of the arm when affixed to the face, Wützer preferred to employ the forearm for the purpose. Quite recently the Tagliacotian method has been successfully employed to restore a portion of the nose by Sir W. MacCormac.¹

The Indian method, introduced from the East, and first successfully performed in Europe by Carpue, is that which has found most frequent application among English surgeons. It consists of three stages or acts, which are conducted in the following order: refreshing the edges of the defect, the formation of the forehead-flap, and, finally, its fixation in its new position. The operation is commenced by paring the edges of the original defect in a triangular manner by means of two lateral diverging incisions, and a third, horizontally or vertically, in the substance of the upper lip, for the insertion of the new columna. These incisions may be made either perpendicularly or vertically to the surface, or, following the suggestion of Bühring, in such a manner that the edge of the flap can be insinuated beneath that of the defect. All unnecessary removal of tissue should be avoided. Cicatrices should, if possible, be included in the incisions, but any remains of the framework of the original organ are to be preserved, unless they exhibit so marked a tendency to curl inwards as to be detrimental to its future shape. A correct appreciation of the size of the flap required is thus obtained, and a model of the part to be restored is cut from leather, gutta-percha, or paper, and fitted in position. After the model has been adapted to the defect, it is spread out in the central or lateral region of the forehead, with its pedicle or narrow end downwards, and its outline traced upon the skin by means of a solution of iodine and permanganate of potash, at least one-quarter larger than the model. A deep incision is then made along the outline thus traced, and the flap, including the skin and subjacent aponeurosis, raised until it is sufficiently free to hang downwards in position without any tension; the point of the knife during dissection being directed towards the pericranium, so as to avoid scoring the under surface of the flap. If the forehead is low in proportion to the other features, the upper end will encroach upon the hairy scalp—an inconvenience which may be avoided by placing the pedicle as low down as possible, or by following the practice of Liston, of subsequently fashioning the columna from the upper lip. As soon as the hæmorrhage has ceased, the fixation of the flap is commenced by uniting the columna to the incision in the upper lip, either by two or three points of interrupted suture, or by a well-curved, fine pin; the alæ are secured in a similar manner,

¹ *Trans. Clinical Soc.* vol. x. p. 181.

and the sides then accurately adjusted by the aid of five or six silk or gut sutures, which, at the pedicle, are inserted at alternate intervals. Finally, the forehead wound is closed as far as practicable by sutures, the elevation of the nose-flap preserved by a piece of drainage-tube, or a loose plug of oiled lint, and the edges of the wound either left exposed or covered by some light antiseptic dressing. At the end of thirty-six or forty-eight hours, when the circulation and sensibility in the new organ are becoming re-established, the sutures are to be removed from the pedicle, the remainder being retained from four to six days, according to the amount of irritation excited and the firmness of the existing union. The after-treatment of the transplanted nose is conducted to prevent the consequences of its contraction, and subsequently to improve its shapeliness. For the former purpose a metal tube or an equivalent support is ordinarily employed; and this should be worn, after the temporary plug has been dispensed with, so long as the nostrils exhibit a tendency to contract or become closed. Secondary operations on the newly-constructed nose may be undertaken without hesitation. If the pedicle be prominent and unsightly, it may be excised by means of two semi-elliptical incisions, or if the nose be large and redundant, its configuration may be improved by judicious excision of elliptical portions of skin; and similarly, when the nostrils are encroached upon by the excessive thickness of the *alæ* and *columna*, this may be rectified by the removal of wedge-shaped or conical pieces from the face of the latter.

The chief of the many modifications introduced into this operation have reference to the position and shape of the frontal flap, which is arranged partly with a view to diminish the torsion and consequent risk of gangrene, and partly with the object of preserving the patency of the nostrils by preventing the contraction of its margins. In the earliest operations the flap was taken from the centre of the forehead, with a bridge of undivided skin separating the pedicle from the defect, and, as a consequence, the torsion was excessive and dangerous. Lisfranc and Dieffenbach partially remedied this by prolonging downwards one of the lateral incisions, circumscribing the flap so as to become continuous with the defect, thus affording a recent wound for the lodgment of the pedicle; and more recently other attempts to secure the same end have been made, either by giving the pedicle an eccentric or oblique position, as recommended by Langenbeck, who places its insertion close to the left internal canthus, with its inferior incision terminating just below the tarsal ligament, and the superior at or just below the inner end of the brow, or by cutting the flap either obliquely or even horizontally from the forehead. Dieffenbach recommended a flap of triangular shape with a quadrilateral *columna* springing from its base, the latter being folded upon itself, whilst the margins of the flap forming the *alæ* were left free to cicatrise. To prevent the concentric contraction of the nostrils, the shape of the flap should be such as to allow the *columna* and *alæ* to be folded over, and for this purpose Labat and Blasius introduced the pyriform flap, from the rounded base of which the *columna* is cut by means of two parallel or diverging incisions.

The earliest exemplification of the French method is the operation performed by Larrey,¹ in which the anterior part of the nose, which had been carried away by a musket-ball, leaving part of the *alæ* and *columna* undestroyed, was restored by detaching the adherent tegumentary margins of the defect, subcutaneously freeing the tissues as far outwards as the cheek-bones, and uniting them in the median line by sutures. This displacement may be facilitated by the addition of horizontal incisions outwards into the cheeks from the base of the defect, or, as this leaves a somewhat shortened nose when the flaps are placed in position, by following the incisions recommended by Szymanowski the lateral margins of the defect are prolonged downwards on each side to a level with the lower lip, and from thence an incision is made obliquely upwards and outwards to a point in the cheek determined by the requisite prominence of the nose, after cutting the *columna* and *alæ* from the lower and outer part of each flap. These are raised and displaced to the median line. Burow's method has also been employed, whilst other operators, as Lisfranc,

¹ *Clin. Chir.* vol. ii. p. 12.

Syme, and Nélaton, have preferred transplantation of flaps of skin having the pedicles situated above at the canthus and the base below.

The ultimate success obtained from these rhinoplastic operations depends upon the degree of preservation or destruction of the natural bony framework of the nose. Where this has been destroyed by disease, or has become so distorted or displaced as to be incapable of sustaining the prominence of the new nose, the results obtained are unsatisfactory; for, however ample the original flap may have been, it gradually flattens from the want of support, until all semblance of the original feature is lost, and the operation fails in its object. Many attempts have been made in cases where the nose has been totally destroyed, or is simply depressed or sunken in, to remedy this difficulty. Artificial supports of gold and platinum plate were tried unsuccessfully by Dieffenbach and Tyrrel; but more recently Leisrink¹ has obtained satisfactory results from the use of amber as a light, unirritating, and non-oxidizable substance for this purpose. With the view of procuring a bony lining to the new organ, Langenbeck,² in 1859, included the periosteum of the frontal bone in the flap; but the amount of bone actually produced proved so fragmentary, owing to the suppuration and granulation of the under surface of the flap, as to be inefficient for the purpose intended, and although the suppuration may be diminished either by folding the flap longitudinally upon itself or by employing two flaps with their periosteal surfaces in contact, the operation failed to fulfil the expectations entertained of it. Nélaton³ also included the periosteum in his method of rhinoplasty by means of two trapezoidal flaps from the cheeks. These flaps have their pedicles above, near the lacrymal sac and their bases below, contain all the soft parts, including the periosteum covering the ascending processes of the superior maxillæ, are detached and brought over the defect, leaving an exposed surface of bone which, as it heals by granulation, produces an adherent cicatrix which has no subsequent influence on the flap. The sides of the nose are kept in contact and supported by a metal pin passed through the flaps, and by the compression of a loop of wire passed over its ends in the form of a pince-nez. In those cases of depressed or sunken-in nose in which portions of the bony framework are still preserved, these have been utilised by Langenbeck and Ollier for a permanent support. Langenbeck⁴ availed himself of the ascending processes of the superior maxillæ, first exposing these by a vertical incision in the median line of the depressed nose, and dissecting up the soft tissues in two lateral halves; then sawing a strip of bone from each nasal process, of sufficient length to support the flaps of the new nose, leaving these attached below, and displacing them upwards by means of an elevator. The remains of the nasal bones being restored to their original position, a narrow frontal flap was then transplanted over the framework thus formed. Ollier,⁵ after failing in an attempt to transplant the periosteum of the tibia to the forehead, combined periosteal rhinoplasty with the transplantation of one of the nasal bones in the following manner. A triangular flap of the tissues of the depressed nose was cut by means of two diverging incisions, beginning above at a central point in the forehead about two inches above the line of the brows, and passing downwards to the level of the inferior border of the nostrils. In dissecting this A-shaped flap from above downwards, the periosteum was included in the upper and frontal part, and below this the left nasal bone, after being detached from its bony connection by scissors, was displaced with it, until the upper border was on a level with the lower margin of that on the right side, to which it was secured by a metallic suture. The septum was divided from above downwards at the same time, and the wound left by the displacement of the flap was united in the median line by sutures. Other solid parts have also been employed, such as the turbinated bones by Nicoladoni and the terminal phalanx of a finger by Hardie. A firm base of support may be obtained by the use of double or superimposed flaps, as adopted by Verneuil, acting on a suggestion of Ollier, in a case where the greater part of the nose had been destroyed

¹ *Centralblatt f. Chir.* 1877, p. 237.

² 'Beitr. z. Osteoplast.' *Deutsche Klinik*, 1859.

³ *Gaz. des Hôpitaux*, 1868, p. 277, and 1862, p. 122.

⁴ *Berlin. klin. Woch.* 1864, p. 13.

⁵ *Gaz. des Hôpitaux*, 1864, p. 469.

by a pistol-shot. After restoring to position the undestroyed columna and lobule, and dissecting up the soft tissues forming the sides of the gutter into two lateral flaps, a third flap was dissected up from the forehead, turned downwards, and over it the lateral flaps applied. Thiersch and others reverse the cheek flaps, and cover these by a single frontal flap.

Partial rhinoplasty includes so many operations, of which many have been designed for individual cases, that more than a superficial notice of the principal types is impossible. Where an opening of small size exists in the bony nose near the root, its closure may be effected by suture of its refreshed edges with or without the aid of incisions; if it be of larger dimensions, the transplantation of a skin flap, either from the forehead, with the pedicle turned toward the opposite side, or from the cheek, becomes necessary. The lateral half of the nose may be restored, after the Indian method, by a flap from the centre of the forehead, or from above the brow, or from the adjacent cheek, or from the skin of the other half of the nose, as performed by Langenbeck. By the last method a triangular or quadrilateral flap immediately adjacent to the defect, with its pedicle above, is dissected up from the cartilage of the healthy side of the nose, transplanted over the gap, and the wound thus produced left to heal by granulation. Busch¹ modified this by leaving an interval of intact skin between the defect and the flap.

The reconstruction of one or both alæ has been undertaken from the tissues of the forehead, nose, cheek, upper lip, and even from the mucous membrane of the septum nasi. The sound skin of the nose is best suited for the purpose, and is obtained from the opposite side (Langenbeck), from the same side (Denonvilliers), or from the root (Busch). Denonvilliers cuts a pedunculated triangular flap from just above the defective ala, and with the pedicle placed internally at the lobule, by an incision commencing near the latter on the sound side, passing upwards nearly to the root of the nose, and from the end of this a second descending obliquely to terminate at the upper and outer corner of the defect. This flap, the lower border of which should contain a strip of the undestroyed cartilage, is then displaced downwards into position. In Busch's operation the pedicle of the flap is long and narrow, and placed either on the opposite ala or below the inner angle of the opposite eye. Weber operates from the upper lip in the following manner. After refreshing the margins of the defective ala, an oval flap, reaching below to the prolabium and with its pedicle attached above to the columna, is cut from the centre of the lip corresponding to the philtrum, and involving only part of its thickness. It is turned upwards, stitched in position, and at the end of a few weeks the pedicle is divided and applied to the inner surface of the flap so as to give a rounded margin to the ala. In place of this, Bonnet employs a quadrilateral flap, involving the whole thickness of the lip by means of two parallel incisions directed downwards behind the defect, and united by a transverse cut below. In fewer cases the loss of substance is limited to the lobule, and is repaired by a long pedunculated flap from the forehead, the pedicle resting in a recent wound produced by splitting the skin of the dorsum of the nose, or from the cheeks, by the method of Labat, by means of two bilateral horizontal triangular flaps with the bases of the triangle placed externally. These are dissected up, reversed so as to expose their deep surfaces, fixed to each other in the median line, and a columna added from the upper lip. Rollet restored the lobule entirely from the latter by cutting a flap 15 mm. broad from its entire thickness, and turning it upwards so as to expose the mucous surface externally.

The material for a new columna is most conveniently obtained from the upper lip. Liston isolated the centre of the lip by two parallel vertical incisions from the nostrils downwards, raised this so that the mucous membrane became external, and after removing its red margin, fixed it by a V-incision into the apex of the nose. Instead of vertically, the flap may be cut obliquely, or horizontally, and from a part only of the thickness of the lip, and twisted upwards so as to leave the cutaneous

¹ *Chirurgie réparatrice*, 1877, p. 428.

surface external; whilst a more rigid columna may be obtained in cases of total rhinoplasty by applying to the inner surface of the flap turned upwards from the lip, the columna of the frontal flap.

Occasionally cases are met with in which the nose is sunken in from loss of its bony and cartilaginous support, whilst the external parts are unaffected; and in a case of the kind, where a deep pit existed in place of the usual prominence, Dieffenbach removed the deformity by splitting and elevating the depressed organ. Two oblique incisions, one on each side of the sunken ridge, were made from the point of the nose upwards, so that the included strip of skin was three times broader at the lower than at the upper end; parallel to the outer sides of these the cheeks were divided down to the bone by incisions which were carried semicircularly round the alæ, and the three strips of skin thus obtained raised, their edges bevelled, and united by suture, and the whole supported by lateral leather splints, with long pins passed from side to side. A similar result was obtained by Sir W. Fergusson and Pancoast¹ by detaching the depressed nose subcutaneously from the parts beneath as far outwards as the infra-orbital foramina, and preserving the elevation thus obtained by approximating the cheeks by a couple of long silver needles.

The operation of total rhinoplasty is not without its dangers, either from inflammatory complication, or, when the flap is taken from the forehead, the possibility of thrombosis of the longitudinal sinus.


Plastic Operations on the Lips (Cheiloplasty. Stomatoplasty).

The reconstruction of the *lower* lip dates from an early period, for a description of its performance is to be found in Celsus, and Tagliacotius practised it by means of a flap from the arm. To obtain a perfectly satisfactory result, the flap should be shaped so as to prevent subsequent retraction and displacement, and preserve the appearance of the natural mento-labial sulcus, possess a sufficient thickness of tissue, which should be derived from the immediate neighbourhood of, and similar to that of the original lip, and its margin, formed of mucous membrane, adequately cover and project from the line of the teeth. The Indian and Italian methods are hardly applicable, although Chopart and Delpech transplanted a flap of skin from the hyoid region by twisting it upwards on its pedicle placed superiorly; but this excessive torsion is prone to result in gangrene. Displacement is far more preferable, and includes a large number of operations, which vary according to the size and shape of the defect. A definite form should be given to the latter by the incisions selected for the extirpation of the diseased part, and experience has shown that one of triangular or quadrilateral outline is best adapted for plastic purposes.

Small *triangular* defects, such as result from the excision of a small epithelial cancer, are not readily closed by simple traction and approximation of the margins; but if the extensibility of the skin be inadequate for the purpose, an auxiliary incision, horizontally outwards (fig. 130), or curved downwards (fig. 137), or excision of triangular parts of the tissues of the cheek (fig. 136) may be added. When the deficiency is of larger dimensions, a cheiloplastic operation, by the transplantation of the adjacent parts in the form of a single or double flap, becomes necessary. Blasius adopted the single flap in cases where the triangular defect is placed obliquely, by carrying an incision from its lower angle downwards over the point of the chin across the median line, and then raising the flap thus obtained into the defect above.

More commonly double flaps are preferred to be taken either from the sides or from below. Dieffenbach formed a rhomboidal flap on each side in the following manner (fig. 134). The tissues of the cheek having been made tense by the finger inserted into the mouth, two horizontal incisions are carried outwards from the angles of the mouth, through the thickness of the cheek down to the mucous membrane, which is then divided on a higher level. From their extremities two other incisions are prolonged downwards, parallel to the sides of the gap, so as to

¹ *New York Medical Record*, vol. xxi.

circumscribe two rhomboidal flaps, which are freely detached from the jaw, displaced towards the median line, and united by the figure-of-eight suture, and the mucous membrane having been folded over to form the free margin, the gaps in the cheeks are left to heal by granulation. These perforations may be obviated by making the flaps acute-angled, as recommended by Szymanowski, or by prolonging the incisions so far outwards that they come to lie over the masseter muscle. Flaps may also be brought up from below by the methods of Reid (fig. 139), or of Syme, in which the tissues of the chin are left undisturbed, and serve to restrain the subsidence of the flaps. Syme made two incisions downwards and outwards from the apex of the defect, and from their extremities carried the knife upwards and outwards in a curved manner, so as to complete two flaps of the accompanying shape , which were raised, and the straight margins united in the median line.

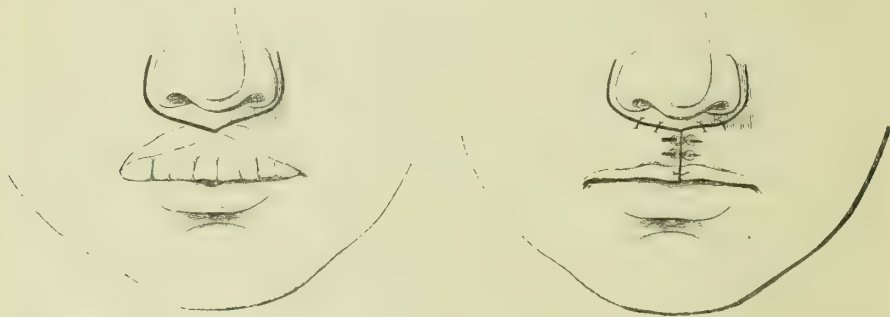
In *quadrilateral* defects of small size, satisfactory results are often obtained by allowing them to heal by granulation without the intervention of a plastic operation. One of the oldest of the latter is that of Chopart, in which a quadrilateral flap is cut from the neck below the chin by two perpendicular incisions from the lower angles of the defect, elevated and stitched in position, whilst the head is kept depressed upon the chest. The lateral sutures, however, prove an insufficient support, and tend to tear out, so as to allow the flap to retract and leave the teeth exposed. Although the tension in these cases may be lessened by adding a horizontal liberating incision below the flap, it is preferable to afford the latter a more solid support by preserving the tissue covering the point of the chin in situ, as in the method of Zeis, who by a Λ -shaped incision on the chin, and two incisions downwards and outwards from the lower angles of the defect, obtained two flaps, united above and separated below, which, when raised into position, are sustained by the tissues left on the chin. If the four-sided defect be trapezoidal in shape, and the adjacent tissues too inflexible for simple displacement, a better result may be derived from the transplantation of quadrangular flaps after the methods of Bruns (fig. 141) or Sédillot. The former is best adapted to cases in which the gap is wider below than above, and the flaps on each side are cut by two incisions, the inner upwards and inwards from the angle of the mouth to the ala of the nose; the outer parallel to it at a distance equal to the height of the defect, which are united above by a transverse or oblique incision. The flaps, after being completely separated from their deep attachments, are brought down and united so that their outer edges form the margin of the lip. In Sédillot's operation, the flaps are taken from below the defective lip by vertical parallel incisions united by one of transverse direction below. Langenbeck preferred a single quadrilateral flap cut obliquely from the tissues of the chin, and separated from the lower margin of the defect by a triangular portion of the skin, which subsequently serves as a support to the flap, after it has been raised through an angle of 45° into position; but as such a flap is devoid of mucous membrane on its internal surface, it loses much of its original pleasing form by subsequent shrinking.

With shallow *elliptical* defects the lower concave edge may be raised and straightened by simply splitting the commissures horizontally, and stitching the extremities of the former to the end of the latter, or by the excision of two triangular portions of tissue, with their apices downwards, and fixing the concave margin in a similar manner. Where the greater part of the lip is absent, Erichsen recommends a modification of a plan of Serre's to raise the lip to a level with the teeth. Horizontal incisions, three-quarters of an inch in length, are prolonged from each angle outwards into the cheeks, and from their extremities oblique incisions downwards to the upper edge of the lip. These triangles are excised, the lip is freed from the jaw, a V-shaped piece taken from its centre, and finally raised and brought forward by bringing together the incisions with harelip-pins. Buchanan's operation for a similar deformity resembles that of Syme. Two diverging incisions are made from the middle of the lower edge of the defect downwards and outwards on each side of the chin, and from their extremities two others upwards and outwards, parallel to the concave margin of the defect as far as the angle of the jaw. These flaps are raised and united in the median line.

One chief desideratum in all these operations is to prevent the puckering and deformity of the new lip, which results from the cicatricial contraction of the cut margin of the new lip by covering it with mucous membrane. Where this is present in the flap, it may be folded over and stitched to the skin, but where it is deficient, it is necessary to transfer it from other parts. Langenbeck transplanted the mucous membrane of the upper lip to the lower by transfixing it close to the philtrum on one side, and detaching it as far outwards as the commissure, leaving it attached at its inner end, cutting a similar strip from the other side, and stitching the free ends of the flaps thus obtained together in the form of a ring, which is then, by stretching, fixed by sutures to the whole of the orifice of the mouth.

Cheiloplasty is much less commonly required in the upper lip on account of the rarity of cancerous affections in this situation; but is undertaken either for cases of aggravated harelip or for the deformities produced by syphilis, lupus, injuries, or burns. In the former case, where the central part of the lip is deficient, an obtuse-angled triangular defect exists with the apex below the nose, and with its edges formed of mucous membrane. Dieffenbach rectified this by bringing a sufficient amount of integument from the adjacent substance of the cheeks on either side. He carried two curved incisions from the apex of the gap round the ala of the nose, divided the mucous membrane attaching the flap to the gum, and then drew down the flaps thus loosened, and united them in the median line by the figure-of-eight suture, so that the margins of mucous membrane formed the border of the new lip (fig. 145).

FIG. 145.



The results of this operation are highly satisfactory, both as regards the appearance of the newly-formed lip and the improvement which it effects in the shape of the nose, previously unduly broad. If the defect be larger and more quadrilateral in form, it is preferable to employ flaps of a corresponding shape from the adjacent tissues of the cheek, and for this purpose an incision is made on each side, from the ala obliquely outwards and upwards, and from its extremity a second downwards and outwards, parallel to the margin of the defect. These flaps are freed as far as their bases, and then rotated downwards until their upper margins can be united in the median line by the figure-of-eight suture. Simpler than this, and more suited to those cases in which only about one-third of the lip is absent, is the displacement in a horizontal direction of two quadrangular flaps from the sides, by means of parallel incisions carried horizontally outward from the alae and from the angles of the mouth. Such a displacement may be facilitated by the device of Burow (fig. 136), excising at the end of the upper horizontal incisions two triangles with the apices upwards, and at the extremities of the lower two of somewhat larger size, with their apices downwards.

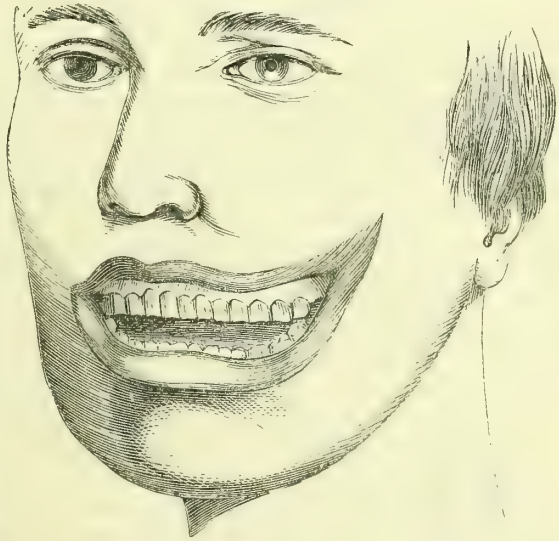
Besides the pathological condition already mentioned, other deformities of the lips and mouth requiring relief by operation are occasionally met with. The chief of these are ectropion of the upper and lower lip, and the malformations of macrostoma and microstoma; and the term Stomatoplasty is employed to designate the operations. In ectropion of the lower lip Dieffenbach arranged three grades of severity. The first and simplest, in which a part of the lip is only involved, is repaired by excising

a triangular portion of the lip including the cicatrice. The second, in which the cutis is destroyed, and the margin of the lip becomes everted and drawn down to the chin, so as to leave exposed the teeth and mucous membrane of the jaw, requires a more complicated measure. The margin of the lip having been replaced in its normal position by separating it from the scar by a crescentic incision and dissecting it upwards, the cicatrice is removed by two converging ∇ incisions, and these are finally brought together in the median line, and united to each other and to the lower edge of the elevated lip by the aid of horizontal incisions outwards from the commissures. In the third degree, in which the scar extends to the neck, Teale¹ has practised the following operation to restore the lip to position. Two vertical incisions three-quarters of an inch in extent are made through the everted lip down to the bone, having the central part of the lip between them, and from their extremities the knife is carried upwards and outwards to terminate opposite the second molar tooth of the lower jaw. The two flaps are freely detached, and, a raw surface having been made along the upper edge of the central undisturbed portion, are raised and united to each other and to the central portion by sutures. A similar deformity in the upper lip by which it is everted and rolled up below the nose, or even adherent to or occupying the situation of the apex of the latter, is relieved either by separating the lip from the jaw, drawing it downwards and filling the gap produced by two lateral quadrangular flaps, or by the following operation of Teale. Two crucial incisions \times are made just below the septum nasi, and two acute-angled flaps thus obtained; these are freed from the bone, drawn across the median line so as to dovetail with each other, and retained by pins and twisted suture, thereby increasing the depth of the lip at the expense of its breadth.

Macrostoma, if congenital (fig. 146), is readily cured by refreshing and union of its

margins; but a cheiloplastic operation is frequently requisite when it results from injury or previous sloughing. Microstoma varies in degree from a limited adhesion of the angles of the mouth to an almost complete atresia oris. In the former, simple division, with union of the skin to the mucous membrane, suffices; but in the latter, unless special precaution be taken, the contraction of the cicatricial tissue invariably reproduces the deformity. Werneck and Dieffenbach were the first to suggest a rational line of treatment to prevent this result, by preserving the mucous membrane to cover in the cut margins. Dieffenbach operated by inserting the sharp blade of a pair of scissors between the skin and mucous membrane as far outwards as the site of the new angle, and removed an elliptical piece of skin by two incisions; having put the still intact mucous membrane on the stretch, he divided it in the median line and freed it sufficiently to enable it to be turned over and stitched to the skin. As the commissure is the part from which contraction is most likely to proceed, this may be more efficiently protected by making the incision in the mucous membrane of $<$ shape, and employing the small external triangular flap to cover in the angle;

FIG. 146. —Fissure of the Lips, after Langenbeck.
(From Larcher, *op. cit.*)



¹ *Med.-Chir. Trans.* vol. xxviii. p. 84, and *Med. Times and Gaz.* 1857, vol. i. p. 501.

or by utilising the extensibility of the existing mucous membrane of the orifice of the mouth in the following manner: a fine scalpel is inserted about one and a half lines from the angle of the contracted mouth, and carried round the red margin of the upper and lower lip towards the median line, so as to detach it in the form of a partial ring; the same manœuvre is performed on the opposite side, and the cheeks having been divided horizontally outwards to the requisite extent, the separated mucous membrane is stitched and secured to the outer extremities of these incisions.

Harelip.—This well-known deformity is a congenital fissure affecting the upper lip. Exceptional instances of a similar malformation of the lower lip have been recorded by Couronne, Nicati, Petit, Fergusson, and quite recently by Lannelongue. These are, however, median fissures, and in the case reported by the last observer, extended through its entire depth, and was associated with a corresponding separation of the lower jaw into two parts held together by a fibrous bond of union. A median fissure is said even to have been found in the upper lip, but it is questionable whether these are not examples of the entire absence of the median portion or philtrum of the lip. Harelip is either single, with the cleft most frequently situated one-quarter to one-third of an inch to the left of the mesial line; or double, on each side of the central portion; or complicated, with deviation forwards of the teeth, with anterior projection of the alveolar margin of one side of the cleft, or the intermaxillary bone, with cleft palate, or with congenital fissure of the cheek. The piece of bone behind the median flap in double harelip and cleft palate, the homotype of the premaxillary bone in lower invertebrata, generally contains the two central incisor teeth, one or both lateral incisors being deficient in the majority of cases.

It is hardly requisite to enter minutely into the nature of the arrest of development to which this deformity is due, beyond the fact that it results from a failure of union between the lateral portions of the upper lip, which are developed from the superior maxillary processes of the uppermost visceral arches growing inwards from the sides, and the central part, which is derived from the naso-frontal process growing downwards from the front part of the head of the embryo. The other congenital fissures of the face—the vertical, extending upwards towards the eyelid, and the horizontal or commissural, outwards towards the ear—are the consequence of a similar failure of union between the several parts of which the face is constructed; whilst the median fissure of the lower jaw is caused by the non-union of the two lateral portions of the inferior maxillary processes of the first pair of visceral arches.

The treatment of harelip is of very ancient date, and the time selected for operation has been the subject of much difference of opinion. Garengot and Dionis waited till the end of the fourth or fifth year, South till the sixth, Sir A. Cooper till after the second, whilst Syme and Dieffenbach deferred interference till after the period of dentition. Such late operations are now discarded, and it is preferable to undertake the performance of the operation at as early a period as is consistent with safety. Delmas and Douglas operated two hours, Douglas seven hours after birth. Guersant only failed once in seven cases undertaken immediately after birth. Dubois advocated the first fortnight of life, Lawrence the third or fourth week, Sir W. Fergusson the end of the first month. Mr. Holmes remarks that simple cases cannot be operated upon too early, whilst a large number of other surgeons consider the second or third month most fitting. Unless contra-indicated by existing circumstances, such as feeble vitality, or the actual presence of disease, as convulsions, intestinal or nasal catarrh or aphthæ, the most convenient period is between the first week and the third month. Chloroform may be given without danger, as the infant quickly comes under its influence, although its administration, especially in very young subjects, is by no means essential.

Operation.—The child having been swathed in a piece of sheeting, and the lips being held by an assistant, who grasps them in their whole thickness to prevent hæmorrhage from the coronary arteries, or secured by some variety of forceps invented for this purpose, the surgeon first finds it necessary to separate the mucous membrane and frænum with a scalpel from the alveolar border of the upper jaw, in order that

the edges may be the more easily approximated. He then seizes the lower angle of each of the sides with fine sharp-pointed spring forceps, and pares the edges of the cleft by introducing a fine narrow sharp-pointed knife at its nasal end, and carrying it downwards on each side so as to remove the edges effectually, including the lower rounded edges. Sharp scissors are preferred by some for this purpose. Without waiting for the cessation of hæmorrhage, which would blanch the infant, the surgeon then passes the harelip-pin deeply through the substance of the lip, so as to control

FIG. 147.—Operation for Harelip with unequal sides, by leaving one of the pared edges (that on the left side) attached, and implanting it into the opposite flap, the edge of which has been sloped to receive it. (From Holmes's 'Surgical Treatment of Children's Diseases.')



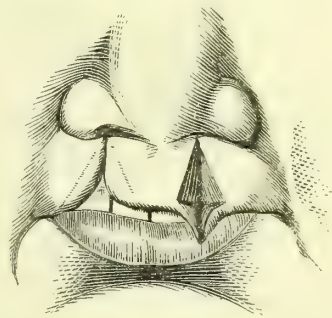
the coronary arteries, commencing from one-third to one-half of an inch from the cut surfaces. A strong silken thread is wound round the pin, bringing the cut edges into contact, in the form of a figure-of-eight. I then prefer to introduce a fine silver suture at the upper end of the wound to bring the nares into shape, and a second at the red edge of the lip to preserve the continuity of that important feature. The child is allowed to sleep, or to suck if it pleases.

Some surgeons prefer to use two pins with the figure-of-eight suture; whilst the pins have been dispensed with altogether by others, and the interrupted suture of silk and silver wire, catgut, fishing gut, or horsehair, or some modification of the shot suture, such as lead sutures, the gun-nipple button of Pollock, or silver discs, have been substituted. Reliance has even been placed upon the support afforded by strapping alone.

Mr. Skey observes: 'In consequence of the greater extensibility of the lower than the upper part, the result of the operation for harelip is to leave a permanent deformity, caused by the retraction of the cicatrix, and the formation of an angle below, at the point of union.' To obviate this evil has been the design of most of the modifications, especially in the arrangement of the incisions, which have been suggested in the operation. Curved incisions or incisions directed inward towards the cleft at their lower part have been employed with advantage.

The Clémot-Malgaigne operation merits attention. The incisions are made from above downwards, but do not detach the flaps, which are turned downwards so as to bring the cut surfaces in apposition and form a projection below the margin of the lip. The parts once united usually shrink and adapt themselves to their new relation; if not, they may be subsequently trimmed to the requisite shape. Henry has modified this procedure by cutting the surface obliquely from the skin to the mucous membrane. Nélaton, in incomplete fissures, transfixes the thickness of lip above the fissure, and carried an incision downwards on each side of it, as far as, but not through the prolabium, so that the same flap, formed thus by the

FIG. 148.—Operation of Clémot or Malgaigne. (From Larcher's translation of the above work.)



entire margin of the cleft, sinks downwards and forms a transverse bridge, which completes the continuity of the lip at this spot.

The operation of Mirault-Langenbeck is represented in fig. 149, and consists of leaving on the shorter side of the cleft the mucous membrane in the form of a flap still attached below, and stitching this to a wounded surface prepared for it at the angle and along the margin of the opposite half of the lip. This short flap should be of considerable thickness, otherwise its apex is liable to slough. Another, but

FIG. 149.—Diagram of an Operation for Incomplete Harelip. Each flap is left attached to the other at its base, the incisions *a, b* not reaching to the red edge of the lip. [N.B. In practice these incisions are not carried so low as they are here represented.] (From Holmes, *op. cit.*)



more complicated method is that of Giraldès (fig. 150) by means of a mortise flap; on the right side by an incision from below upwards so as to leave the flap adherent above, and on the left by one in the reverse direction so as to leave it adherent below. The former is turned upwards and the latter downwards, and the two attached by interrupted sutures so as to form the line of union shown in the diagram.

Mr. Collis¹ utilises all the parings in a somewhat different manner, after previously dividing all the false fræna, and, if necessary, detaching the ala of the

FIG. 150.—Giraldès's Operation for Complicated Harelip, in which one flap is left attached by its upper, and the other by its lower end, and the two are dove-tailed together. (From Thévenin, 'Considérations sur le Traitement du Bec-de-lièvre compliqué.')



nose from its connections. After the intermaxillary bone has been dealt with, the longer margin of the cleft is pared by an incision which divides the thickness of the lip as far as the mucous membrane on its inner surface, but not through this, beginning at the nostril, following the curve of the cleft, and ending on the margin of the lip opposite the frenum. The opposite edge of the fissure is then transixed near the nostril, and the knife carried downwards parallel with the edge, so as to detach a moderately broad flap attached above to the ala and below to the free margin of the lip. This is divided into two parts at its centre, and the upper half turned upwards so that its raw surface faces the wound previously made in the opposite side of the fissure, to the upper end of which it is then secured, and the lower half turned downwards and fixed to the lower end of the same wound. The refreshed edges are brought

¹ *Dublin Quarterly Journal*, vol. xlv. 1868, p. 294.

together by horsehair sutures, and a lip is thus obtained twice the depth of that by the ordinary method. Mr. Stokes¹ also employs partial incisions somewhat differently arranged. After making an incision through the entire thickness of the lower part of each side of the cleft, and bringing the ends of these downwards so as to form a projection below the lip, the upper angle of the fissure, when this is incomplete, is divided vertically by means of scissors. From the upper end of this cut, two incisions are carried downwards, through three-quarters of the thickness of the lip only, to join those first made, and to form two narrow quadrilateral flaps, which remain attached by their mucous membrane behind, and are turned back until their raw surfaces can be brought into contact.

In operating on harelip, the endeavour should be to avoid all tension in the approximation of the edges of the fissure, particularly in those cases where the cleft is wide and extends into the nostril, the nose broad and distorted, the ala flattened out towards the cheek, and, together with the margin of the cleft, adherent to the jaw beneath. Simple division of any fræna or reflection of mucous membrane is then inadequate for the purpose, and a free careful separation of the ala and lip from the bone by means of the scalpel, kept closely to the latter, is required until the lip can be drawn with facility into the desired position; a result which in exceptional cases of double harelip may necessitate subcutaneous freeing of the lip and cheek for a considerable distance outwards, even as far as the infraorbital foramina.

It is customary to remove the harelip-pin about the fourth day. It should be gently withdrawn, and, if the dried figure-of-eight piece of silk remain adherent, it may be left on the lip, where it serves as a plaster. There are some who remove the pin on the third day; others who leave it till the sixth or seventh. In the one case the union may be still too weak to hold; in the other, the pin may have cut its way out by ulceration. If the sutures are of silk, they should be taken away in twenty-four to forty eight hours; if of silver, they may remain as long as the surgeon thinks proper. At the time of the removal of the harelip-pin, the cheeks should be well pressed towards the middle line by an assistant, that no accident may occur to the newly-united parts by the act of crying which commonly ensues. If the union is not very firm, the parts may be supported by strapping or by the use of Hainsby's cheek compressor.

The operation for double harelip, although more complicated, is similar in its performance to that of the single variety, but is subject to some slight modification according to the size and development of the central part of the lip. However small and apparently useless this may be, it should always be preserved, and if unavailable for the repair of the lip, may afford the material for constructing the columna and supporting the apex of the nose, which is commonly flattened and misshapen. Both sides are to be operated on simultaneously, and the central part is refreshed in a V or U-shaped manner. The former is preferred when this piece of the lip is small, and the lateral margins of the cleft are united to it above and to each other below, so that a Y-shaped cicatrix results. When the central flap is well developed and of square shape, the latter is adopted, and if the parings of the lateral margins of the double cleft be preserved according to the method of Malgaigne, the red margin of the lip may be restored by turning these downwards, and uniting them by their extremities in the middle line and to the inferior refreshed edge of the central part above. Mr. T. Smith advises that the parings from the central tubercle should be turned downwards and attached to prepared surfaces on the inferior margins of the lateral parts of the lips.

The most important complication influencing the operation of harelip is a cleft through the alveolus and palate, with prominence of the intermaxillary bones. In single harelip this may project to such a degree on one side, and may be so much in advance of the opposite edge of the cleft, that it is impossible to unite the soft parts over it without employing so much tension as considerably to increase the risk of failure, and it becomes necessary to deal with it either by forcibly bending it back-

¹ *Dublin Quarterly Journal*, vol. 1. 1870, p. 4.

wards to a better position—for which purpose Mr. Butcher employed a pair of cutting forceps which divided it but left the mucous membrane behind intact—or by completely removing it. Sir W. Fergusson recommended the latter, either by cutting it away at the mesial line with bone forceps, or by first separating the soft coverings and then scooping out the bony interior together with the milk tooth by means of a gouge. In double harelip the premaxilla forms the bony support of the middle part of the lip, is attached sometimes by a narrow pedicle to the anterior extremity of the vomer, follows the growth of the latter, and is displaced by it upwards and forwards, in the most marked cases to such a degree that in profile it appears to spring directly from the apex of the nose and to exist as an appendage of this. Several plans have been advocated to overcome the obstacle which such a malposition opposes to the union of the soft parts. Franco and Dupuytren excised the prominent tubercle, a practice which was followed by Sir W. Fergusson, who never hesitated to remove it when it seemed the least in the way of a satisfactory operation, and in order to prevent the hæmorrhage, which was occasionally free, divided the mucous membrane, stripped this off, and shelled out the small bone from its interior. Verneuil also, with the same object, enucleated it sub-periosteally. Before excision the small central part of the lip should be dissected freely from its anterior surface and turned upwards to form a columna for the nose. The loss of the central part of the bony arch leaves the lip unsustained, retracted by inspiration, and liable to disunion from the movements and suction of the tongue, and causes a want of correspondence between the upper and lower dental arches in their after development. For this reason, it is preferred to retain it by rectifying its malposition. Desault employed compression by strapping, but the process is both tedious and uncertain. Gensoul forcibly fractured its neck of attachment to the vomer in order to facilitate its reduction to a proper position. This is effected, after dissecting the central part of the lip from the bone, by forcibly pressing back the latter with the thumb or with a pair of forceps covered with lint until it is on a level with the lateral margin of the cleft. Some difficulty may be experienced in young children when the septum is cartilaginous, and when the base is very thick its division by bone-forceps is necessary. The part thus displaced frequently fails to acquire firm connections, and the teeth when they grow out slope so much backwards as to be useless for purposes of mastication. Sir W. Fergusson mentions a case in which he was called upon six years after the operation to remove the tubercle which has thus been bent backwards on account of its unsightly appearance. Butcher takes the precaution of twisting the teeth into a more regular position before bending back the bone. Attempts have also been made to secure a firmer junction between it and the maxillæ by paring the edges of both and fixing them either with periosteal or bone sutures, or with a fine needle passed through the maxillæ and intermaxillary bone; or, if the latter be larger than the space for its reception, it may be trimmed so as to accurately fill this in the manner of a keystone of an arch. Broca believed himself to have obtained bony union of the tubercle by refreshing the edges and passing sutures through it and each side of the jaw. In order to provide a greater space for the bone thus pushed backwards, Blandin excised a triangular portion of the vomer immediately behind it, but in these cases it still remains loose, and the hæmorrhage is frequently profuse. To diminish the latter, Bruns encircled with a ligature the part of the vomer behind that to be excised, and removed it some days later; but a more efficient means is to employ the subperiosteal method, for not only is the risk of hæmorrhage thus diminished, but a firmer union is ensured by the new osseous development. This is performed by making a longitudinal incision along the inferior edge of the vomer dividing the mucous membrane and periosteum, and after detaching the soft parts with an elevator, excising a triangle of bone. A method of reducing the projection, when this is not excessive, by means of the gradual pressure of the soft parts united over it, was tried by Simon, who restored the lip by means of two lateral flaps derived from the lips and cheeks, and united them with the central soft part over the tubercle. Mention has previously been made of the deleterious influence exerted by the tongue of the infant on the recent adhesion in those cases where a cleft exists

in the bone, and it only remains to notice briefly the attempts which have been made to counteract this. Broca used a shield of gutta-percha arranged in front and behind the sutures; Goyrand restricted the movements of the tongue by a form of tongue-depressor; whilst Verneuil accomplished his purpose by means of a gutta-percha obturator fitted to the breach in the bones; but these procedures are either difficult in their application or inefficient in their action, and are but rarely necessary.

Plastic Operations on the Cheek (Meloplasty).

The practice of meloplasty is intimately associated with that of cheilo- and blepharoplasty, for the disorders which produce the local destruction of parts in the cheek proceed primarily from the lid or the lip, especially when the affection is of a cancerous nature. A description of the operations included in the affection term would be without special interest, for all the above-mentioned fundamental methods, especially those of gliding, find exemplification in this region according to the size and shape of the defect. Whatever form the latter may possess, the incisions or flaps should be made laterally to it, if possible, for the effect of the operation is rendered thereby less noticeable. If the flap be taken from above, encroachment on the region of the lid and ectropium may result; or if from below, the movement of the lip may become restricted. Care should also be taken to avoid the branches of the seventh nerve, and to diminish the shrinking of the flap on its internal surface by preserving as much of the original mucous membrane as possible in extirpating the disease.

Plastic Operations on the Ear (Otoplasty).

Defects of the external ear attract so little attention and produce so little disturbance of function, and may be so easily concealed, that plastic operations are rarely required. A partial restoration was practised by Tagliacotius, by a flap, not taken from the arm, but from the skin of the cheek or behind the ear, twisted into its position and doubled upon itself. Dieffenbach has also succeeded in repairing the upper and lower part of the pinna by single flaps taken from above or below the ear. Having pared the edge of the ear, he raised a quadrilateral flap by making a parallel incision at the same level through the adjacent scalp, and two vertical incisions from each end. The margin of this flap was united to the edge of the ear and oiled lint drawn underneath. At the end of three weeks, as soon as union was perfect, the flap was detached and trimmed to the shape of the ear. Szymanowski describes operations of total restoration by means of a flap cut from the skin of the head behind the original ear, in such a manner that the posterior half of the flap can be doubled beneath the anterior so as to form a fold of skin, which is subsequently shaped into the proper form.

Plastic Operations on the Penis and Bladder (Urethro- and Cystoplasty).

Fistulous openings communicating with the urethra anteriorly to the scrotum rarely close by the natural efforts of repair, and even defeat repeated attempts of the surgeon to effect this result. This failure is to be attributed in part to the thinness of the penile coverings, the small surface these afford for adhesion, and the insufficient granulating process of which they are capable, and in part to the disturbance to healing from contact with the urine, and from the mobility, varying size, and erections of the organ. Such local peculiarities require to be taken into consideration in practising plastic operations on this part. Whenever a stricture exists the treatment must be preceded by the careful employment of the catheter; but in the antescrotal fistula, before a cure is accomplished, this has to be supplemented by one or more of the following operative measures—(a) cauterisation, (b) urethroraphy, (c) urethroplasty. The stimulation of the fistula by some caustic substance to induce a development and subsequent contraction of granulations is best adapted to those of small size or to those capillary openings which so frequently remain after the major portion of the defect has been closed by a plastic operation. Sir A. Cooper

succeeded completely in one case by the use of nitric acid, whilst Dieffenbach preferred frequent pencilling of the fistulous track with tincture of cantharides ; but the success of many such operations is not permanent, owing to the fistula reopening to the force of the stream of urine. Urethroraphy is performed by refreshing the edges of the fistula to the extent of an eighth or a quarter of an inch, and uniting them by sutures either in a longitudinal or transverse direction, according to the facility with which this can be performed, over a catheter, which is permanently retained or only introduced as occasion requires. The great difficulty of excluding the urine from contact with the recently-approximated margins induced Ségalas to divert its course altogether from the anterior part of the urethra by conducting the catheter through an existing perineal fistula into the bladder ; and, in this way, he obtained the union of a fistula an inch and a half long by a single operation, with the exception of a fine opening which was subsequently closed. About the same time Ricord was equally successful in a similar case, directing the urine by a female catheter introduced into the bladder through an artificially-established perineal fistula, a procedure which has been advocated and regarded as essential to success by Sir H. Thompson,¹ Dane,² and other operators ; but, inasmuch as it introduces into the operation an additional element of risk, and many successful results have been attained without its aid, it should be employed as an exceptional precaution rather than a universal measure. The sutures used in the majority of cases to bring the margins of the fistula into con-

FIG. 151.



tact have been the interrupted of silk or wire, but many other varieties have found favour with different operators, including a combination of the deep and superficial suture, the twisted, quilled, or some adaptation of the leather, lead, or silver splint combined with the shot or button suture. Le Gros Clark maintained adhesion between the surfaces of the flaps by four square leathern splints, secured in position by platinum wire ; and Lane attributed the good results which followed the application of Bozemann's leaden plate, after the fistula had been united by silver sutures, to the support and uniform stretching thus secured to the line of union. A special form of suture—the lace suture—proved of service in the hands of Dieffenbach, and consisted of a thread passed subcutaneously around the fistulous orifice, the ends being brought out and knotted at the same opening. As regards the success following these operations, Czerny³ found that out of twenty-three cases collected and tabulated by him, four healed by first intention, thirteen by granulation, two were improved, and in four failure resulted.

The operations of urethroplasty proper embrace examples of all the chief modifications of the various plastic methods, viz. :—A. Union of the refreshed edges, (a) by the aid of one or two liberating incisions ; (b) by the formation of a bridge-flap. B. Transference of a flap, (a) by lateral displacement ; (b) by torsion. C. Superimposed or double flaps. A single liberating incision of considerable length along

¹ *Clin. Soc. Trans.* 1871, vol. iv. p. 68.

² *Brit. Med. Journ.* 1872, vol. iv. p. 209.

³ *Archiv f. klin. Chir.*

the dorsum of the penis proved successful in two cases in which it was adopted, but the plan of double lateral incisions (fig. 151), first employed by Dieffenbach, who refreshed the margins of the fistula in a lozenge-shaped manner over a catheter, and added on each side a longitudinal incision to lessen tension, has been more favourable in its results. Antero-posterior may be substituted, if necessary, for the lateral incisions. By dissecting up the skin from its deep attachments between these incisions and the fistula, a bridge-flap, attached by its two extremities, is obtained, which affords a broader surface for contact and diminishes the risk of urinary infiltration. Nélaton, by the aid of a double antero-posterior bridge-flap and the twisted suture, and utilising a second opening existing posteriorly to empty the bladder, effected the closure of a fistula which had resisted four previous operations; but an attempt by Sir H. Thompson to apply this method to a fistula measuring an inch and a quarter failed from gangrene of the flaps, and an apprehension of a similar result induced Richard to omit the twisted suture, and leave the margins to close by granulation and approximation by a loose suture. In cases where the fistulous opening is situated close to the scrotum, Dieffenbach recommended a single bridge-flap from the skin of the scrotum, by first refreshing the fistula in an elliptical manner over a catheter, making a transverse incision two inches behind, and drawing forwards this flap sufficiently to secure it to the anterior margin of the fistula. The results of these operations, according to Czerny, are not superior to those of simple urethroraphy.

In cases where the loss of urethral substance has been greater, and the fistula of correspondingly large dimensions, firmer support is afforded, and the tension of the surrounding parts lessened, by the use of a true flap, either by the method of displacement or tension. The former comprehends single or double lateral or antero-posterior flaps. One of the oldest and most successful applications of the single lateral flap is that by Alliot,¹ who loosened a quadrilateral flap on one side so as to draw it over the opening and attach it, not to the margin of the latter, but to a recent incision about six lines distant from it. A most extensive defect, involving three inches of the continuity of the urethra, was also almost completely closed by Jobert by a unilateral flap from the skin of the penis and scrotum. Bilateral flaps were employed successfully by Le Gros Clark in such a manner as to bring their surfaces into contact for adhesion; but a similar procedure failed in the hands of Pollock² in a case which is especially instructive from the success eventually obtained after repeated failures. The fistula was one inch and a quarter in length, and, after the first unsuccessful operation, seven successive attempts to close the fistula by refreshing its edges and adding lateral incisions failed from the persistent recurrence of erections about the third day. After the opening had thus been reduced to the size of a crowquill, it was finally and effectually closed by bringing the edges together transversely with superficial platinum sutures and a deep one of silver wire fixed by a Bozemann's leaden plate, from which all tension was removed by a longitudinal incision along the dorsum of the penis. An antero-posterior quadrilateral flap from the skin of the scrotum was especially advocated by Jobert; but in two cases thus operated upon a cure was only completed at the end of seventeen and four months respectively. Sir H. Thompson,³ however, refers to a case of immediate union of a scrotal flap, and attributed the fortunate result to the complete exclusion of the urine from the wound by the patient's skilful and systematic use of the catheter.

Less adapted for the purposes of urethroplasty is the method of torsion; for, although Sir A. Cooper, in one of the earliest operations on record, closed a urethral fistula half an inch in length by twisting a scrotal flap over it, other attempts in this direction have mostly failed, such as that of Delpech, in which the flap was transplanted from the inguinal region, and was destroyed by sloughing after division of its pedicle. The tendency for the urine to excite suppuration, and even sloughing, in flaps which have their raw surface turned towards the fistula has led several operators to adopt the

¹ *Med.-Chir. Trans.* vol. xxviii. 1845, p. 413.

² *Brit. Med. Journ.* 1858, p. 781.

³ *Lancet*, 1868, vol. i. p. 430.

system of double or superimposed flaps to protect the exposed surface and lessen this risk. Much variation exists in the arrangement of these flaps. Rigaud reversed a scrotal flap, and covered this in by two flaps from the sides. Sédillot turned two lateral flaps over the fistula, and protected these by one displaced from before backwards; whilst Mr. Wood,¹ after treating the existing stricture of the urethra, raised an oval flap from the side, reversed it over the fistula, and fixed it to the opening by silver sutures; then, raising the surface around for about an inch and a half, so as to procure a broad surface for adhesion, dissected up a triangular flap of skin from the scrotum, and brought this forward so as to cover the surface prepared for it.

In these operations the risk of failure chiefly lies in the difficulty of excluding the urine from the surface of recent union, and the stretching to which the latter is liable to be subjected by the occurrence of erections. To overcome the former, the catheter must be used, and in the majority of cases has been retained in the bladder until union was perfect. Several successes have thus been obtained, but failures are not infrequent owing to the urine, after a few days, escaping by the side of the instrument, which is also prone to cause cystitis and to excite ulceration of the urethra behind the fistula. Consequently this use of the catheter has been modified on several occasions. The introduction of an instrument two or three times a day by the patient, when he is sufficiently skilled in its use to undertake this, is the most efficient way of preventing the urine from reaching the wound; but where this is not practicable, a soft catheter should be retained for three or four days, and then passed at intervals by the surgeon, or a gum-elastic catheter introduced into the bladder through an opening in the perinæum after the method of Ségalas and Ricord. Erections may be controlled by the use of cold local applications, as ice, together with the administration of sedatives hypodermically, or suppositories of belladonna and camphor per rectum.

Hypospadias, the commonest of all the congenital malformations of the urethra, is classified, according to the position of the urethral orifice, into the balanitic, penile, scrotal, and perineal, and, following the arrangement of Duplay, the peno-scrotal and perineo-scrotal varieties. In front of the opening, the urethra is either absent altogether, or simply fissured from absence of its inferior wall, or in some cases partially pervious, whilst the penis is small and deformed, and either attached to the scrotum by a cutaneous web, or curved abruptly downward by a fibrous bridle on its under surface representing the undeveloped urethra and fibrous capsule of the corpora cavernosa. The operations for the relief of this deformity are directed towards the following objects—(1) to redress the above-mentioned malposition of the organ, which interferes with the functions of micturition and sexual intercourse, and (2) to restore the canal of the deficient urethra; and it is advisable to complete the former before proceeding to the latter. When the penis is attached to the anterior surface of the scrotum, Bouisson² recommends simple division of the membrane, dividing it from base to apex by means of a bistoury, which is kept at a sufficient distance from the urethra to avoid its injury, and to preserve an adequate amount of skin to cover its inferior surface; the liberated penis is raised towards the abdomen when the wound becomes longitudinal or lozenge-shaped, and is united by sutures. The downward curvature of the organ is rectified by simple or subcutaneous division of the tense bridle on its inferior surface. Bouisson passed in a tenotome through a small opening, and subcutaneously incised the unyielding tissue, together with the fibrous septum between the corpora cavernosa, and obtained a perfect restoration of shape. In some cases the superficial tissues are too thin and adherent to permit this, and simple transverse incisions from within outwards have been preferred by Anger and Duplay, the tissues being dissected through, layer by layer, until the corpora cavernosa were exposed, and the penis could be raised, straightened, and fixed to the abdomen.

The germ of these operative procedures for the relief of hypospadias is as ancient as Paulus Ægineta, who proposed to remove that portion of the urethra in front of the

¹ *Brit. Med. Journ.* 1872, vol. ii. p. 207.

² 'De l'Hypospadias,' *Tribut à la Chir.* t. ii. p. 487.

orifice. In modern times the re-establishment of the canal has been undertaken by (a) perforation, (b) union of the margins of the fissured urethra, or (c) transplantation of the adjacent tissues.

Dupuytren is said to have practised perforation of the glans with a successful result by introducing an expressly constructed trocar along the anterior and inferior part of the organ, as far as the hypospadiac opening, and cauterising the canal thus established. This was followed by excessive inflammation, which threatened destruction of the entire penis, and at the end of three months urine passed along the new canal, which, however, showed a strong tendency to contract. Guersant operated on ten cases in this manner without any durable beneficial result, and although Maisonneuve made an ingenious suggestion to limit the degree of contraction by lining the floor of the new urethra with a narrow flap of skin drawn in from behind through the hypospadiac orifice, the operation is now abandoned, partly from the danger of sloughing and partly from the consecutive contraction of the new canal. In those rare examples in which the urethra is simply fissured on its under surface, and exists as a deep groove, and where approximation of its edges restores the extremity of the canal, its re-formation may be effected by refreshing the edges and uniting them over a catheter, as described by Dieffenbach, who used the twisted suture, and where much tension existed divided the groove longitudinally to acquire more room for the catheter. Sir W. Fergusson states that his endeavours to unite the skin over a catheter failed to produce a permanent result. Usually the urethra is deficient partially or completely, and its reconstitution is only possible by transplantation from the neighbouring tissues. Liston was successful in protecting the exposed mucous membrane, and prolonging the canal by turning a part of the prepuce backwards and uniting it behind without any twist; and Dieffenbach turned two lateral flaps over a catheter, leaving the exposed surfaces to heal by granulation, but the use of double or superimposed flaps yields more certain and satisfactory results, as in the methods of Anger or Duplay. In an example of peno-scrotal hypospadias, Anger¹ first rectified the curvature of the penis in the manner above described by division from without inward. As soon as the effect of this operation was fully recovered from, a longitudinal incision was made on the left side from the glans to the scrotum parallel to the site of the urethra, and $1\frac{1}{2}$ cm. from the mesial line, and at the extremities of this two short transverse incisions inwards and towards the middle line so as to form a flap which, when raised and reversed, formed the new canal. To cover this the skin of the penis and scrotum was detached on the right side from the middle line outward until this flap, overlapping the other, could be made to oppose its free edge with the corresponding border of the opposite wound. The first reversed flap was rolled round a catheter, so as to form an epidermic canal, and fixed by six (deep) sutures; each of which was first passed through both its free and attached edges, and then both ends through the base of the covering flap, where they were fixed by the shotted suture. The superficial flap was finally united with the margin of the skin of the penis on the opposite side. Duplay's² operation for perineo-scrotal hypospadias is more complete, including, as it does, the construction of a meatus in its natural situation, and proceeds on a plan similar to that first employed by Thiersch in epispadias, of forming the urethra in separate sections. After separating the penis from the scrotum by division of the muco-cutaneous band, and by several incisions on the fibrous capsule of the penis, six months was allowed to elapse before the second part of the operation was commenced. The first stage consisted of the restoration of the meatus by refreshing the margins of the existent groove and uniting them by sutures; and the second, of the creation of the new urethra backwards to the urethral opening by means of two lateral quadrilateral flaps. These are obtained by making two longitudinal incisions parallel to the median line, with short transverse incisions in front and behind, so as to form two narrow flaps, which are then turned over a catheter with their skin surface towards the new canal, and covered in by two additional flaps formed by

¹ *Bull. et Mém. de la Soc. de Chir.* vol. i. 1876.

² *Ibid.*

prolonging the transverse incision outwards and dissecting up the skin of the penis. The flaps are secured to each other by sutures passed obliquely through the margins of both on one side, across the median line, then through those on the opposite side, and knotted externally, and also to the glans in front. The third stage, the closure of the posterior fistula, is accomplished by paring the edge and using deep and superficial sutures, with a catheter retained for two or three days. In most of these cases the prepuce is redundant, and may serve to provide material for the new canal. Mr. Wood,¹ in a case of penile hypospadias, transferred this to the under surface by passing the glans through an incision made in its base, and attached to its hinder margin a skin flap brought forward from the skin of the under surface of the penis in order to complete the canal; and Mr. Pick² adopted a similar measure as a first step in a case of the peno-scrotal variety so as to form a bridge below the glans, the rest of the urethral floor being completed by a reversed oblong flap from the side, covered in by one displaced laterally with its base upwards and outwards. With regard to the age at which these operations should be undertaken, Duplay recommends that the malposition of the organ should be remedied at an early period, so that its development may not be interfered with, whilst the formation of the canal may be deferred to a later period.

Epispadias is less common than hypospadias, but produces greater functional disturbance, and has therefore been the occasion of more numerous efforts to mitigate the deformity by operation. It is complete and incomplete, according as it is limited to the glans or extends into the body of the penis; and in the latter variety the penis is much shortened, flattened, and curved upwards and to the left side, the prepuce is present as a kind of apron on its under surface, the corpora cavernosa are approximated to or separated from each other, and the urethra forms a groove of varying depth and breadth on the upper surface, and terminates behind in a funnel-shaped orifice leading into the bladder, frequently sufficiently large to admit the finger. In former times the affection was regarded as incurable; but Dieffenbach³ was the first to recommend, in 1837, in cases where the urethra was represented by a deep groove on the glans, its reconversion into a canal by refreshing the margin with scissors, and uniting them with the twisted suture over a catheter. This had already been put into practice by Liston,⁴ who closed four inches of the urethra in this manner. Bégin in 1838 suggested the propriety of detaching the skin for a short distance before uniting its edges. Foucher also attempted to form the urethra entirely of mucous membrane by separating it from the skin and bringing it together separately; but it was not till 1852, when Nélaton first employed the method of reversed flaps, that the treatment of epispadias by plastic operation was placed on a satisfactory basis. His first method of operating consisted in turning downwards over the penis a quadrilateral flap from the skin of the abdomen immediately above the urethral orifice, equal in breadth and somewhat longer than the undeveloped organ. The exposed raw surface of this flap was then covered by two lateral flaps brought up from the sides of the penis, and these united to each other and to the abdominal flap beneath by fine pins, which were removed on the third day. At the end of a month the urethral canal was completely formed, but of so ample a width as to permit the introduction of the finger and necessitate subsequent cauterisation to diminish its excessive size. The abdominal flap in this case showed a strong tendency to retract, and to lessen this as much as possible a somewhat different procedure was followed in the second case. The penis being fixed by a thread through the prepuce, two longitudinal incisions were made on each side a little to the outside of the urethral groove, and the skin dissected up for a short distance. These incisions were carried upwards on to the abdomen for about 15 cm., united transversely above, and the abdominal flap thus obtained turned downwards as in the first case, and fixed to the edges of the lateral longitudinal incisions. Over this was transplanted a flap from the whole of the anterior surface of the scrotum, which was limited by two curved incisions, the upper corresponding to the groove between the

¹ *Medical Times and Gazette*, 1875, vol. i. p. 115.

² *Lancet*, 1879, vol. ii. p. 727.

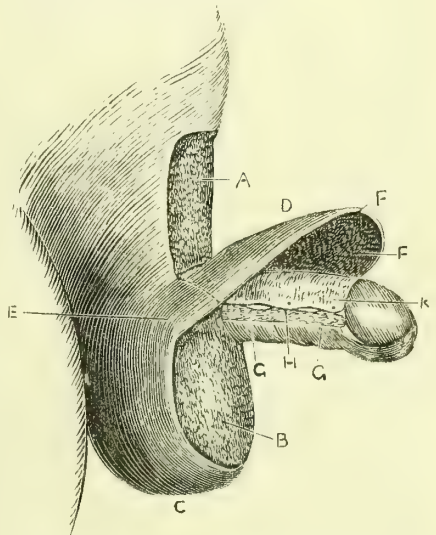
³ *Die operative Chirurgie*, 1845, vol. i. p. 544.

⁴ *Practical Surgery*, 1840, p. 573.

penis and scrotum, with its concavity upwards, and the lower parallel to and at the requisite distance from the first. This was liberated except at its extremities, raised over the penis, and fixed to the abdominal flap by sutures, in this way preventing in great measure the retraction of the latter. Dolbeau¹ operated in a similar manner by an abdominal flap, 7 cm. long and 2 cm. broad, stitched to the edges of two narrow skin flaps on each side of the gutter, and covered in by the scrotal flap, as above described. The condition of the patient was much ameliorated by these operations, but the glans remained uncovered and the artificial urethra abnormally large, conditions which were obviated by the plan of operating initiated by Thiersch² in 1869, of constructing the urethra in separate sections, which has since served as a model for most of the subsequent operations. A perineal fistula was first established as a preliminary measure to deviate the course of the urine during the period occupied by the operation, but is now abandoned as unnecessary. The operation is commenced by converting the groove on the glans into a canal by means of two longitudinal incisions, one on each side of and parallel to the groove, and carried downwards for some distance in a convergent direction into the substance of the glans, so as to divide this into a central and two lateral parts. The latter are refreshed over a broad surface immediately to the outer side of the longitudinal incisions, raised and brought together, with the raw surfaces in contact, by figure-of-eight sutures so as to cover in the central portion and the groove, and convert this into a canal. As soon as union is complete, the second step of restoring the penile urethra is accomplished by two lateral rectangular superimposed flaps; that on the right side by means of a longitudinal incision close to the groove as far back as the epispadiac opening, with short transverse incisions outward at each end, and that on the left by a similar longitudinal incision 1 cm. from the groove, and transverse incisions inwards up to its margins. Both of these are dissected up, the left turned over the gutter with its cuticular surface inwards, and its free

margin secured by three or four quilled sutures to the angle of the base of the right flap, which is then slid over the raw surface of the left, and its free margin stitched to the outer edge of the defect left by this. The third stage completes the junction of these two portions of the canal by utilising the apron-like prepuce on the under surface of the penis. The glans is passed through a transverse incision in the base of this, one layer of which is then united to the penile part of the urethra behind and the other to the glans in front. More difficult than this is the final step of the operation, the closure of the funnel-shaped opening posteriorly so as to direct the urine along the new canal. A double flap is employed for the purpose, on account of the uncertainty of union by simple suture, one of triangular shape taken from the left side with its base corresponding to the left half of the upper circumference of the orifice and turned downwards and stitched over the latter, and covered in by a second of quadrilateral shape from the right side, with its base in the inguinal region

FIG. 152.—Nélaton's Operation for Epispadias. (From Larcher's translation of 'Holmes on Surgical Diseases of Children.')



A, the part from which the abdominal flap has been taken; B, the part from which the scrotal flap has been taken; C, the lower part of the scrotum; D, the scrotal flap, which has been notched in the middle of its base to allow the penis to be slipped through it; E, the lateral adherent parts of the scrotal flap; F, F', the anterior border and bleeding surface of the scrotal flap; G, G', the refreshed edges of the skin of the penis; H, the raw edges of the abdominal flap; K, the bleeding surface of the scrotal flap is to be applied.

¹ *De l'Epispadias*, 1861, p. 49.

² *Archiv d. Heilkunde*, 1869, X, Jahrg. 1. Hft.

parallel to Poupart's ligament. To overcome the objection to constructing the urethra of skin flaps, Duplay¹ has modified this operation so as to assimilate the constitution of the new as closely as possible to the structure of the normal urethra. He suppresses the artificial fistula, and separates the operation into three stages. The penis is first straightened by one or more dorsal incisions, and after this is completed the urethral canal is restored from the end of the penis to the opening behind by a single operation. On each side of the groove which exists between the corpora cavernosa, and along its whole length, the tissues are refreshed to the extent of 5 or 6 mm., a sound placed in the groove, the corpora cavernosa approximated over it and brought into contact by a single-wire silver quilled suture. The epispadiac opening is finally closed by freely revivifying its margins and uniting them by the quilled suture over a retained catheter.

The highest degrees of epispadias are associated in a number of examples with a similar condition of the bladder, ectopia or extroversio vesicæ, resulting from a congenital deficiency of the anterior wall of the bladder and of the corresponding part of the abdominal parietes, with separation of the pubic symphysis, and producing a protrusion of the posterior vesical wall through the hiatus in the form of a vascular dark red projection, on the lower part of which are situated the orifices of the ureters, from which urine unintermittingly escapes.² The condition is one of a peculiarly distressing character, and the imperfect relief afforded by palliative measures renders the patient willing to subject himself to any operative procedure likely to mitigate his sufferings. Half a century ago Delpech suggested the possibility of remedial operative measures, and in 1844 Wattmann failed in an attempt to unite the skin over the bladder in the median line after dissecting it up from the subjacent tissues; but this remained an isolated fact till Mr. Simon³ in 1852 succeeded in a case which came under his care in establishing a fistulous communication between the lower ends of the ureters and the rectum, with the object of diverting the course of the urine entirely into the latter. The patient lived for a year, and the practice was repeated by other operators; but, owing to the risk of injuring the peritonæum which it involved, and the imperfect attainment of the desired object, was soon abandoned. Quite recently Mr. T. Smith⁴ avoided the peritonæum by securing the ureters to the ascending and descending colon from the loins; but the fatal result of the case very shortly after the second operation conclusively demonstrates the failure of this principle of operating. With these exceptions, the autoplasmic method has been invariably resorted to to afford relief by restoring the anterior wall of the bladder by means of one or more flaps of skin borrowed from the neighbourhood; and the arrangement of the flaps employed have either been (*a*) reversed, (*b*) superimposed, (*c*) granulating, or (*d*) single and recent, according to the operator. Reversed flaps were adopted by Roux,⁵ Maury, and Pancoast.⁶ Roux's operation in 1853 consisted of dissecting a flap from the abdomen above, and one from the scrotum below, and uniting them in a reversed manner over the exposed bladder, so that the raw surfaces were turned outwards; the flaps were destroyed by gangrene. Maury modified this in the following manner: A large convex flap was cut from the scrotum, perinæum, and groin by an incision extending from Poupart's ligament on one side to that on the other, separated freely from the subjacent tissues and turned upwards, after slipping the penis through a small slit in its base, until it lay with its skin surface over the bladder, its upper margin being insinuated beneath a short flap of integument raised from the soft parts above, and at the sides of the opening the two were fixed to each other by the tongue and groove suture. A highly successful operation was performed by Pancoast in 1858 by means of lateral reversed flaps taken from each side of the protrusion, with the base or adherent edge towards the latter, over which they were turned. Union of the margins took place by first intention, and the raw surfaces healed by granulation. In these cases the protracted cicatrization of the recent and exposed surfaces of the flaps is a great disadvantage,

¹ *Bull. et Mém. de la Soc. de Chir.* 1880.

³ *Lancet*, 1852, vol. ii. p. 570.

⁵ *L'Union Méd.* 1853.

² See *Diseases of Urinary Organs*, p. 180.

⁴ *St. Barth. Hosp. Reports*, vol. xv. p. 9.

⁶ *North Amer. Med.-Chir. Review*, July 1859.

and may be obviated by covering this in by the addition of other flaps. In France this device had been successfully followed by Nélaton in operating on a case of epispadias, and in 1854 was selected by Richard¹ for a case of extroversion. A flap from the skin of the abdomen immediately above the protrusion, with its base turned towards the latter, and sufficiently long to extend down to the junction of the bladder and urethra, was reversed, and over it and the exposed urethra was transplanted a second flap from the whole of the anterior surface of the scrotum, attached on each side by broad pedicles $4\frac{1}{2}$ cm. wide; but the operation terminated fatally on the eighth day from peritonitis. The earliest successful application of this principle were made by Mr. Holmes² in England, and Dr. Ayres³ in America. The operation of Ayres was undertaken on an adult female in 1858, and consisted of turning down from above the bladder over the protrusion a flap of skin measuring five inches by three, of a sugar-loaf shape, and covering in its raw surface above by gliding the skin from the side over it, and below by folding the apex of the flap upwards upon itself. Union having occurred, the remaining part of the tumour and the urethra were covered over in a second operation by turning downwards the apex of the flap which had been reflected upwards, and uniting the edges of the skin over this surface in a manner similar to the first operation. Mr. Holmes obtained three successful results from five cases by the method of lateral reversed flaps. One flap of square shape is taken from the groin sufficiently large to cover the protrusion over which it is reversed like the leaf of a book, and the other from the opposite side of the scrotum running obliquely downwards from the margin of the bladder, which is dissected up and gently twisted round to cover the former. After the union of these flaps is secure and a bridge formed across the bladder, its upper margin is implanted into the skin of the abdomen above by refreshing the contiguous edges and uniting them with the twisted suture. In this way the exposed surface of the bladder is protected and covered over, and increased facility for fitting a urinal is afforded. Mr. Wood⁴ obtained good results from the same operation, but the delay occasioned by the second operation which is necessary to close the umbilical fistula, and the difficulty with which this is attended, induced him to modify it and to cover in the bladder at a single operation by reversed umbilical, and superimposed lateral flaps in those cases where the thickness of the abdominal parietes in the umbilical region is sufficient for the purpose. The umbilical flap is of sub-quadrate shape, extends the whole width of the bladder transversely, is dissected up to within half an inch of the exposed mucous membrane, and turned downwards with the integument towards the bladder; its raw surface is covered by two lateral flaps of pyriform shape taken from the groin, with the pedicles directed towards the scrotum and thigh so as to contain the main vascular trunks, displaced inwards towards the median line, and secured to each other and to the deep flap by three long harelip-pins. The wounds which are left are partially closed by pins, and the whole braced up by a broad slip of plaster passed across the abdomen. As soon as this is completed, and the flaps securely united, a supplementary operation is undertaken to remedy the epispadias. A collar of skin is turned down from the lower margin of the transplanted flap, the skin from each side of the penis raised and reversed over the groove on its upper surface, and over the whole is superimposed a horseshoe flap from the scrotum. Ashurst,⁵ after partially covering the bladder by Wood's method, completed it by a modification of Richard's operation, reversing a flap from that left by the previous operation, together with two laterally from the groin, and superimposing on these a large saddle-shaped scrotal flap. The case terminated fatally thirteen hours after operation from cardiac thrombosis. When the reversed flaps are derived from a part provided with hairs, the growth of the latter forms a troublesome after-complication, and although Pancoast asserts they

¹ *Gaz. hebdom.* 1854, vol. i. p. 120.

² *Surgical Treatment of Children's Diseases*, 2nd ed. p. 149.

³ *Congenital Exstrophy of the Urinary Bladder.* (New York, 1859.)

⁴ *Med.-Chir. Transactions*, 1869, vol. lii. p. 85.

⁵ *Am. Journ. Med. Sci.* 1874, vol. lxvii. p. 421.

in time cease to develop and gradually fall out, such a result is by no means invariable; sometimes from their persistence they lead to calculous incrustations, and require removal from time to time by the hand of the surgeon or the patient. For this reason Thiersch rejects the reversed and especially the umbilical flap on account of the liability to endanger the peritonæum during its dissection, and its tendency to slough from insufficient nutrition; and, to prevent the injurious action of the urine on a raw surface exposed to its contact, he prefers the system of granulating flaps. After closing the urethral epispadiac groove by his own method, he employs two lateral flaps to cover the bladder, each individually sufficiently large to close the defect. The first is intended for the lower half of the bladder, and has its inner margin close to the edge of the latter and to the root of the penis, and the outer parallel to it and reaching down to Poupart's ligament; it is left attached above and below until granulations develop on its deeper surface, when the upper attachment is divided and the granulating flap laid across the lower half of the bladder and united with its opposite edge. A similar flap is cut on the opposite side at a higher level to cover the upper half, and finally the glans penis is united to the lower flap by refreshing and suture of its edges.¹ The operation lasted a year until its final completion: it has been put into execution with a successful result by Sir W. MacCormac.² Professor Billroth³ in his more recent operation has also adopted the granulating flap, dissecting up on each side of the bladder two deeply-pedunculated flaps, 6 cm. broad at their centre and 5 cm. at the base, sufficiently freely to overlap each other for about half their width. At the end of ten or twelve days the granulations and superficial cicatrization are removed from their contiguous margins, which are then united in the median line, leaving the lateral openings to close spontaneously, which they do in about six weeks. Of four operations of this kind two were successful, one died of pyelitis after a successful operation, and one was incomplete. The frequency of this cysto-pyelitis in these cases of extroversion of the bladder has been remarked by Billroth as strongly tending to diminish the chance of a successful operation by destroying the flaps, and of ultimate recovery. When to the operation of closing the anterior wall of the bladder is added the restoration of the canal of the urethra so as to form one continuous channel, the condition of the patient is greatly benefited; for, although the incontinence is unaltered, a urinal can be so easily and perfectly fitted to the small penis that any escape of urine over the surrounding parts is prevented, and in exceptional cases the individual may even acquire the power of retaining, when in a horizontal position, small quantities of urine. Attempts to substitute the light pressure of a truss for the absent sphincter, in order to dispense with the urinal, have been badly borne, owing to the delicacy of the skin and its liability to excoriation, whilst an operation planned and executed by Hirschberg⁴ to restore a functional sphincter likewise failed. This operator, proceeding on the view of Simon that urine when acid and natural has but little deleterious influence on recent wounded surfaces, succeeded in transplanting in a child of sixteen months old a sufficiently large single recent flap from the left side over the bladder, with its raw surface inwards, and obtaining union by primary adhesion. Five weeks after closing the bladder he attempted to restore its sphincter. After drawing upwards the skin flap and exposing the mucous membrane, the latter was dissected on both sides from the abdominal wall for about $\frac{3}{4}$ cm., its edges refreshed and united by four silk sutures, so as to form a lining of mucous membrane for the new bladder. The effect for a few days was striking in retaining the urine; but on the eighth the mucous membrane sloughed and separated, and the condition remained as before. Besides these autoplasmic operations, other measures have been employed. Earle tried to destroy the mucous membrane with escharotics, without success. Bigelow⁵ dissected off the mucous membrane of the bladder as far as the uterus, and obliterated the cavity by drawing over to the median line two lateral flaps from the groins, and

¹ *Centralb. f. Chir.* 1876, p. 504.

² *St. Thos. Hosp. Repts.* 1880.

³ *Chir. Klinik*, 1879, p. 329.

⁴ *Archiv f. klin. Chir.* 1875, Bd. xviii. S. 727.

⁵ *Boston Med. and Surg. Journ.* vol. xciv. p. 1.

quite recently the bladder has been extirpated in a case by Sonnenburg, the ureters being stitched to the groove on the penis.¹

The statistics of these operations have been compiled by Ashurst, who has collected 55 cases, of which 43 recovered, 4 failed, and 8 died—a percentage of 14·6 of deaths.

The Treatment of Contracted Cicatrices.

Among all the vicious cicatrices that the surgeon is called upon to relieve, there are none that tax his ingenuity, patience, and skill to a greater extent, or afford so many vexatious disappointments, as those which follow the destruction of the entire thickness of the skin by the application of heat. In these the cicatrization is associated with a process of excessive after-contraction which proceeds slowly, almost imperceptibly, until changes as regards the limbs most serious and the face most hideous are produced. The cicatricial skin becomes raised into prominent cords or bridles of whitish or reddish colour, which grow thicker as the contraction becomes more complete, and, pulling upon the surrounding integument, draw it into folds and pucker it up towards the centre. It is particularly in cases of severe burn about the neck that these ulterior consequences and changes in the surrounding parts are to be observed in the most prominent degree. The head becomes rigidly fixed and drawn downwards to the sternum, so as almost to obliterate the anterior surface of the neck; the chin is depressed and its prominence lost in the projecting cicatrix; the lip is everted, so that the saliva continuously escapes, and the mucous membrane, gums, and teeth are exposed; the latter are directed in an anterior direction; the body of the jaw becomes altered, and the other features of the face deformed. Altogether the appearance of a most repulsive deformity is presented, interfering with the functions of mastication and phonation, and, if it occurs at an early period of life, arresting the bones of the face and spinal column in their development, and altering the relationship of the deeper structures of this region. For such a calamity surgical ingenuity has been pushed to the uttermost to devise measures of relief. Some surgeons have been content to rely exclusively on that obtainable by extension alone, either of a manual or mechanical nature; and little doubt can be entertained that, in suitable cases, an intelligent and patient application of this principle will suffice to rectify the existing deformity. Under its influence the contraction gradually yields, provided the most stringent precautions be adopted to prevent any tearing or laceration of the cicatricial surface, the firm cords become soft and pliant, and the new skin regains the suppleness, if not the completeness, of the natural structure.

For the extension of a cicatrix in the neck we employ a pelvic band of steel, with two side crutches and a webbing-band in front to keep the instrument steady; a posterior steel upright, to which is attached a headpiece with branches, movable in every direction by means of cogwheels and a strap passing under the chin. Every day, or every other day, the smallest possible amount of extension must be made and maintained; but the patient should suffer no pain, nor must the skin be allowed to break.

In slighter cases a greater amount of benefit will ensue from direct pressure; a piece of vulcanised india-rubber is moulded exactly to the contracted part, and is retained there by a bandage, strap, or elastic roller. This practice is useful in cases of contraction of the elbow in children; also in the treatment of contractions of the neck, especially in combination with the extending apparatus, when the chin seems lost in the deformity, and the teeth are assuming a horizontal direction.

In a considerable proportion of cases, however, such a treatment is disappointing in its results, especially when the cicatrix is old, dense, and unyielding. Moreover, the lengthened period of time over which it must be extended before a definite improvement is secured, the liability to the ulceration of the scar, and the tedious delays thus incurred whilst such accidents are repaired, and the great difficulty of maintaining the instrument in its exact and rigid position, so as to effectually employ the extending force in certain parts of the body, have induced surgeons to strive to obtain an equally

¹ *Berlin. klin. Woch.* 1881, No. 30.

satisfactory and more expeditious result by means of the operative art. As a consequence, a large number of plans have been suggested and practised at various times, many of which have now fallen into desuetude or been replaced by more desirable methods. Simple division of the cicatricial band by a transverse incision, followed by mechanical extension and reposition, was practised by Dupuytren and other surgeons. The incisions are single or multiple, and are made to extend the whole depth and breadth of the bridge, so as to divide the whole of the inodular tissue, and usually through its central and most dense portion; after which the position of the limb is redressed gradually and continuously by the aid of bandages or some mechanical contrivance, or by elastic or weight extension. When excessive force is employed for this purpose, the risk of inflammation and even gangrene is considerably increased. Mr. Skey proposed in place of the broad incision to obtain extension of the cicatrix by means of a number of minute divisions, both of the skin and subjacent tissue, on the ground that the contraction of wounds is slight according as the time of healing is short; and Decès has diminished the wounded surface left by these multiple incisions by arranging them in an undulating or zigzag manner, so as to destroy the parallelism of the fibres of contraction. But this practice fails frequently in its object; the newly-formed cicatrix becomes the seat of secondary contraction almost as severe as the previous one, and the deformity reproduces itself; consequently they have now been abandoned. In 1814 Earle¹ adopted the plan of completely removing the contracting structure by dissecting it out, restoring the deformed part to its position, approximating the edges of the wound as closely as possible by strapping, and allowing the rest to heal by granulation; but the number of cases to which this operation can be applied is limited to those in which the cicatrix consists of a narrow bridge, such as are rarely to be found, implicating the front of the neck. James, of Exeter,² considered the failure of previous attempts in the neck to depend upon the complication and flexibility of the joints in the vertebral column, and the alteration produced in these; and, with the object of maintaining a separation between the base of the skull and thorax, inserted a steel collar, consisting of two steel arches, one resting on the sternum and the other below the jaw, and separable from each other by screws. He operated by first dissecting up the cicatrix, and completely freeing it from its connection in the neck, until it was elevated and secured below the chin, and applying the collar as soon as suppuration was established. Other surgeons have been content to dissect up the flap until all deformity was removed and restoration of the head effected, the wound being left to heal by granulation. Rynd³ made a semilunar incision external to and below the scar in the neck, in sound skin of the chest, extending nearly from ear to ear, and, dissecting up the flap towards the chin, included in it the fascial membrane below, and divided all processes seated deeply inwards, until the lip was freed and the mouth closed. The flap was then pushed up and adjusted under the chin, the portions of sound skin on each side drawn towards each other, and the wound left to granulate. Butcher⁴ combined this with subcutaneous detachment in a case where the cicatrix was laterally placed on the neck, rapidly dissecting this up by a curved incision at its lower part, dividing all bands and resisting structures until the head could be raised into position, then, with a long narrow-bladed bistoury thrust upwards subcutaneously, the remainder of the cicatrix above was freely divided from its attachments until it became perfectly loose and unfolded. The wound produced was left to granulate. The length of time necessary for complete recovery in these operations may be considerably reduced, when the incision adopted for the dissection of the flap can be so arranged as to permit the union by sutures of the edges of the raw surface left behind. With this object in view Blasius circumscribed the cicatrix by a V incision, and was able, after the flap had been dissected up and the natural position

¹ *Med.-Chir. Trans.* vol. v. 1814; vol. vii. 1816.

² *Ibid.* vol. xiii. 1825, p. 152.

³ *Dublin Quart. Journal*, vol. xxii. 1856, p. 93.

⁴ *Op. and Conservative Surgery*, 1865, p. 758.

of the head restored, to bring the edges of the wound thus produced together in a Y-shaped manner ; but this procedure is not altogether free from the possibility of a recurrence of the deformity, particularly when undertaken before the period of after-contraction in the scar which is preserved has subsided. Many cases are met with in which such a stretching of the opposite margins is altogether impossible, owing to the large surface exposed after the scar has been completely set free, and for these, the Indian method of transporting the adjacent healthy tissue to fill the gap and to replace that destroyed is to be preferred. When such autoplasmic measures are applied to the relief of vicious cicatrices of the neck, the tissue of which the flap is composed is derived either from the chest-wall or from the lateral regions of the neck itself. The flap must be of considerable thickness, raised with the entire thickness of the subcutaneous tissue, and so arranged that it can be rotated without difficulty over the surface which it is intended to cover, where it is carefully fixed by suture to the surrounding healthy and cicatricial margin. The earliest of these operations was performed by Carden,¹ who first divided the scar by a transverse incision through its entire extent, drew it carefully under the chin, and then, having raised a flap from each side over the clavicle and the neck, united these in front. His example was followed by Mütter, who recommended that the incision through the scar should extend from the sound skin on one side to that on the other, and that a flap should be transplanted from the neck, shoulder, or thorax, after every band of adventitious tissue had been divided. The flaps from the neck may be provided by dissecting up the edges of the wound, and gliding inwards towards the median line two lateral flaps ; or by leaving these attached only above and below in the form of a bridge, as advocated by Mr. Mason,² who, after incising the scar transversely through its centre, and thoroughly separating the two halves, made two curvilinear cuts along each side of the gap, detached two bridges of skin, and displaced these inwards towards the centre. In many cases the tissues covering the upper part of the chest-wall are more serviceable, for the skin is thicker, less prone to shrink after separation, and is capable of providing flaps of considerable dimensions. Mr. Teale³ transplants a flap from below the clavicle into the gap produced by the division of the cicatrix, and prefers, if the cicatricial surface be extensive, to repeat the operation at several times. He relies on the adhesion between the deep surface of the flap and that of the defect, and avoids too accurate adaptation of its margins to the cicatrix by sutures, since these rarely unite by first intention ; but, in spite of the disinclination for union exhibited by these parts, every opportunity should be afforded by the use of sutures and coaptation of the edges to ensure a large surface of adhesion without suppuration and consequent granulation ; and, as remarked by Mr. Holmes,⁴ it is of especial importance to secure the early union of the upper edge of the flap nearest the lip, in order to prevent the formation of a horizontal band of cicatrix likely to follow sloughing or granulation of the flap at this spot. M. Péan⁵ attempted to utilise the cicatrix, after it had been dissected up, to cover the surface on the upper part of the thorax left by the transplantation of a flap to the neck ; but the propriety of this is questionable, since, by reason of its deficient vitality, it is highly prone to slough. The cicatrix was first freed by dissection down to the upper border of the sternum, where it was left attached, and the head thereby restored to position. A flap was then cut from the right upper part of the thorax, by a vertical incision along the right border of the sternum, for its upper third, and one parallel to this from the coracoid process downwards. These were united below, the flap raised, and, by mobilising the pedicle, placed over the cervical wound ; the cicatricial flap from the neck was drawn downwards, so as partially to cover the wound on the thorax, but eventually sloughed. These autoplasmic operations may be employed alone or in combination with other measures, as in a successful case by Mr. Wood⁶ with extension and excisions, and are effectual in palliating, if

¹ *Trans. Med. and Surg. Assoc.* vol. xii. 1839.

² *St. Thomas's Hosp. Repts.* 1872.

³ *Plastic Operations.* Lond. 1857. *Med. Times and Gaz.* 1857, vol. i. p. 564.

⁴ *Lancet*, 1863, vol. i. p. 322.

⁵ *L'Union médicale*, 1868, 3ème série, t. vi. p. 191.

⁶ *Med.-Chir. Trans.* 1863, vol. xli. p. 149.

not altogether removing, many diseased conditions which were previously regarded as beyond the reach of surgical art.

Transplantation of Skin. Skin-grafting.

Early experimentation had demonstrated the feasibility of transferring completely detached portions of skin from an individual, or one part of the body, to a recent wound prepared for it in another; but these attempts remained isolated incidents and unserviceable for the general purposes of practice until the facility which attended such transplantations when applied to a granulating surface was pointed out by M. Reverdin. This observer, to whom the idea had suggested itself from observation of the apparently spontaneous formation of individual centres of cicatrization in granulating wounds, published in 1869 an account of an experiment which he had performed of transporting small flaps of the superficial layers of the skin to the surface of a wound covered with granulation, where they became adherent, grew and enlarged, and materially accelerated its cicatrization. The experiment was repeated by other surgeons and his conclusions confirmed, and at present this little operation, now divested by time and experience of the exaggerated ideas previously entertained of its capabilities, remains permanently established as a most valuable therapeutic method in the treatment of large and tardily-granulating wounds. Its essential characteristic consists in the transference of small particles of cutaneous tissue, limited to the epithelium only, or embracing part of the cutis, to a granulating surface, although other epithelial structures may and have been similarly treated. Hairs thus implanted, by Schwenger,¹ with their root-sheath into granulations, formed a centre of cicatrization, and a delicate pellicle of new epidermis, not exceeding the size of a sixpence, the lining membrane of a congenital atheromatous cyst, and the mucous membrane from the uvula and from a polypus have also taken root, and Mr. Macleod² records an example of striking success obtained from the epithelial elements of the fluid from a recent blister, under which, when applied with its coagulum in a layer over the wound, cicatrization was almost complete in four days. These skin-grafts are ordinarily supplied from another part of the body of the same individual, and usually from some region—such as the inner surface of the arm—where the skin is thin and devoid of hair; but they may be procured from other persons, as in the grafting from the skin of a negro, from recently-amputated limbs, or from that of the cadaver. When the skin is furnished by other individuals, those only must be selected who are free from constitutional taint, for Drubel³ records a case in which a granulating surface, having been covered with dermo-epidermic grafts from an individual, the subject of secondary syphilis, these broke down a month afterwards consentaneously with an outbreak of syphilitic roseola; and even such affections as variola are asserted to have been transmitted in this manner.

Three different methods of operating have been employed. M. Reverdin⁴ transplanted as far as possible the epidermis alone, considering that thin grafts with very little derma succeed much better than those comprising the thickness of the latter; and for this he proposed the term 'epidermic grafting.' M. Ollier,⁵ who employed the grafts not only for the purpose of influencing cicatrization, but also as a complementary procedure to plastic operations, preferred pieces of considerable size, comprehending the whole thickness of the true skin, 'dermo-epidermic grafting,' with the view of substituting for the thin, delicate, unstable layer of new formation, which he asserts is the product of the epidermic method, a fleshy, thick, stable cutaneous layer, which, in spite of the absence of glands, fills the rôle of the skin. A third plan of transplanting the scrapings of the superficial layers of the epidermis, 'scale-grafting,' was advocated by M. Sée and Dr. Fiddes,⁶ but the results obtained are confessedly uncertain.

All wounds are not equally adapted for the purposes of grafting. A congenial

¹ *Leitsch. f. Biol.* Bd. xi.

² *British Med. Journal*, 1871, vol. i. p. 335.

³ *Gaz. médicale*, 1881, No. 45.

⁴ *Archiv. gén. de Méd.* 1872, p. 276.

⁵ *Bull. de l'Acad. de Méd.* 1872, p. 242, and *Bull. gén. de Thérap.* 1872, t. lxxxii. p. 325.

⁶ *Lancet*, 1876, vol. ii. p. 870.

soil is necessary for the success of the operation, and the surface of the wound requires special preparation for the reception of the graft. As a general rule, the more closely it approximates to a healthy granulating surface, the greater the probability of a successful transplant; but other conditions than this are apparently requisite, for the grafts may fail to become attached to an apparently healthy surface, and may even succeed in unhealthy or rupial sores. It is advisable to wait until, by appropriate treatment, the surface of the wound becomes covered with small uniform red even granulations, bathed in a moderate amount of healthy purulent secretion, and the margins are soft, supple and natural. The operation is simple in performance, and most surgeons select the method of Reverdin, of taking small portions involving the epidermis only, or with a thin section of the papillary layer of the corium. A small fold of skin having been pinched up with a fine pair of hooked forceps, a piece about $\frac{1}{6}$ – $\frac{1}{8}$ in. in diameter is shaved off with a sharp bistoury, leaving a small circular dimpled depression, which, if it does not involve the papillary tissue, remains white and does not bleed, or in a few seconds oozes a drop of blood, which dries, and beneath which the small wound rapidly heals. The small flap of skin is then transferred to the thumb-nail and divided into four smaller portions, each of which is transferred with the point of the knife to the granulating surface, on which it is laid with slight compression at regular intervals about three-quarters of an inch from the margin and about an inch from each other. After completing the requisite number the wound, if of moderate size, may be simply covered with a piece of 'protective' and surrounded by cotton-wool and a bandage, or the grafts may be separately covered with strips of isinglass plaster, and the rest of the wound dressed with some simple application. In place of the bistoury, Reverdin raised the portion of skin with a lancet inserted horizontally. Ollier recommended a large-bladed Beer's knife. Ordinary scissors or iris-scissors are employed by others, and a special form of combination of scissors-forceps was invented by Mathieu. The grafts have also been inserted into the granulations by an incision, as practised by Mr. Pollock,¹ but the hæmorrhage liable to ensue endangers their adhesion. Much difference of practice exists as to the size of the piece of skin taken, the epidermic flap of Reverdin being 2 to 3 mm. square, whilst the dermo-epidermic flaps of Ollier are from 4 to 8 cm. These larger grafts inflict more pain during removal, and leave behind a wound of considerable size, which heals by granulation, and sometimes so slowly that it may be still unhealed at the completion of cicatrisation of the ulcer. The dressing on subsequent occasions resembles that adopted after the operation; the protective being removed on the second or third day, the surface and edges of the ulcer should be cleansed by allowing a gentle stream of tepid water from a sponge to flow over it, taking especial care to avoid displacing the adherent grafts, and the same dressing should then be reapplied. In this way cicatrisation may proceed without any necessity of further surgical interference until the grafts have attained a certain size, when a second series of pieces are engrafted in a manner similar to the above.

The changes which occur in the graft after it has been placed upon, and become adherent to the granulations, vary somewhat, according to the size of the piece employed. If the piece be small, within a few days it loses its superficial epithelium, which softens and degenerates, so that it is deprived of its whitish surface, and, becoming transparent, assumes the colour of the surrounding granulations. It then constitutes a fine delicate smooth membrane permeated with blood-vessels, which in some cases requires careful examination to discover, and is present either in the form of a smooth pellicle of bluish aspect, or as a red depressed spot. In other cases, especially when the graft is of larger dimensions, it retains its whitish aspect throughout. At a date which is variable, but generally about the end of the first week, the growth of new epithelium begins, the graft assumes a pearly-grey aspect, and then subsequently becomes white; it increases at its margin usually in a circular manner, or more rapidly on the side opposed to the margin of the ulcer or to an adjacent graft, sending forth linear prolongations of epithelium to meet those developing

¹ *Clin. Soc. Trans.* vol. iv. 1871, p. 37.

in a similar manner from the margin, until the space between these becomes bridged over and the two coalesce. This activity of the graft may be delayed for many days or weeks, and Pollock mentions one example in which nine weeks elapsed before it exhibited any evidence of vitality. The extension and growth of the graft is not indefinite, it rarely increases beyond the size of a sixpence or a shilling—a fact which proves the necessity of multiple grafts. It may attain a certain size, and then remain without further increase. Ollier saw one thus become stationary for four months. It may atrophy and disappear altogether when the wound is attacked by erysipellatous inflammation; or, as Levis has seen, during an attack of fever. A very remarkable behaviour in some grafts which had attained the size of a shilling has been noted by Mr. Prescott Hewett¹; as the graft extended by its circumference its central part became absorbed, so as to present a ring-like appearance.

It is a generally accepted view that the essential element of the graft is its epithelium, and more particularly the cells of its deeper layers, the rete mucosum; but in what manner these cells act in determining the increased activity of epidermal growth which takes place is still a moot point. It would seem from some of the experiments made with black-skin grafts to determine this question, and in which the area of pigment has increased with the growth of the part, such as that of Bryant, in which the black graft enlarged to twenty times its original size, and those of other observers, that the graft increases by actual proliferation and growth of its own epithelium; but the results of these experiments are by no means uniform. Reverdin has seen grafts from the negro, in place of increasing, lose colour, and become white, having its newly-formed epithelium around of natural appearance; and Coste has also noted that the grafts gradually paled from absorption of its pigment. With such conflicting experimental evidence, actual conclusions as to the conduct of the epithelial cells are difficult; but Poncet² states, from microscopic examination of recent grafts, that he has never seen any indication of proliferation in the cells of the rete mucosum, and attributes the epidermal new growth to the direct act of the cells of the mucous layers, determining by their presence and contact the transformation of the embryonal cells of the granulation into epidermal cells.

The immediate object of skin-grafting is to establish individual centres in ulcerated and granulating surfaces, from which cicatrisation proceeds independently, so as to expedite healing and to induce an increased cicatrisation from its margins. This is incontestable; but as to its more remote objects, the greater solidity of the cicatrix and the prevention of after-contraction, there is less unanimity of opinion. Many such cicatrices break down when exposed to adverse conditions as readily as those which result from the ordinary process of healing; and this is readily conceivable from the fact that their constitution is almost exactly similar to that of an ordinary scar.

R. W. LYELL.

¹ *Lancet*, 1875, vol. i. p. 124.

² *Lyon médicale*, 1871, t. viii. p. 494.

AMPUTATION.

PART I.

AMPUTATION is often regarded as an opprobrium of the healing art. But while the human frame remains liable to derangement from accident or disease, the removal of hopelessly disordered parts, in the way most conducive to the safety and future comfort of the sufferer, must ever claim the best attention of the surgeon. Indeed, the progress of medical science, while furnishing the means of curing some affections once regarded as hopeless, and thus in one sense restricting the field for the application of amputation, has in another point of view extended that field, by improving the mode of operative procedure, and divesting it of much of its terror and danger; so that whereas in former times the removal of a limb was only resorted to in cases of the most serious nature, it is now often practised when the unoffending member is merely a source of inconvenience.

It is instructive to trace the history of the improvement of this department of surgery.

Hippocrates (B.C. 430) recommended only a very rude kind of amputation, consisting of cutting through mortified limbs at some joint, 'care being taken not to wound any living parts.'¹

On the other hand, Celsus, who seems to have lived at the commencement of the Christian era, advised that the removal of gangrenous limbs should be effected between the dead and living parts, and so as rather to take away some of the healthy textures than leave any that were diseased; and as he interdicted amputating through an articulation, his operations must often have been performed entirely through sound tissues. He directed that the soft parts should be divided with a knife down to the bone, and then dissected up from it for some distance, so as to allow the saw to be applied at a higher level. The rough surface of the sawn bone was then to be smoothed off, and the soft parts, which, as he tells us, will be lax if this plan be pursued, were to be brought down so as to cover the end of the bone as much as possible. This method seems calculated to afford good results; particularly as it appears probable from his writings that Celsus employed the ligature for arresting hæmorrhage after amputation,² and dressed the stump in a manner favourable to the occurrence of primary union.

Archigenes, who practised in Rome shortly after the time of Celsus, paid special

¹ *Hippocrates de Articulis*, p. 639 of the Sydenham Society's translation.

² On this interesting point in surgical history I am disposed to agree with the author of the article 'Amputation' in Rees's *Cyclopædia*, in opposition to the prevalent opinion that Celsus employed the ligature only in ordinary wounds, and used the actual cautery in amputations. The directions of Celsus regarding amputation are contained in his chapter on the treatment of gangrene, in which the only mention of hæmorrhage is the statement that patients often die of it during the performance of the operation (*in ipso opere*), referring doubtless to profuse bleeding resulting from ignorance of the circulation of the blood, and of any means of controlling it in the limb. Certainly this expression is no proof that the cautery was used rather than the ligature; for the former is the more speedy method of the two. Neither is the absence of allusion to the ligature in this passage any evidence against its employment after amputation; for the argument would apply equally to the cautery, and no one doubts that one of these two means was used. Celsus, who is remarkable for his extremely concise style, leaves us to refer to his previous chapter on wounds, in which the subject of hæmorrhage is very ably discussed. In slight cases pressure with dry lint, and a sponge wrung out of cold water, is recommended, or if this does not answer, lint steeped in

attention to the control of hæmorrhage during the performance of the operation ; and appears to have been the first to employ for this purpose a tight band or fillet encircling the limb above the site of amputation. But while in this he did good service, he applied the red-hot iron to the surface of the stump and also neglected the dissection of the soft parts from the bone, advised by Celsus, though compensating to a certain extent for this omission by retracting the integuments before dividing them.¹

Galen, who was in truth more of a physician than a surgeon, declined still more from the Celsian precepts, and reverting to the practice of Hippocrates, advised amputating through the dead tissues and applying the cautery to the residue of the mortified part ;² and for several centuries after his time either this method or others equally rude and often much more barbarous continued to be employed.

During the middle ages, the ligature, though used for ordinary wounds, was never thought of in amputation, and whatever may have been the practice of Celsus in this respect, there is no doubt that the great French surgeon Ambroise Paré, when he so applied it, in the middle of the sixteenth century, had all the merit of originality. But, though he urged its superiority over the cautery with able argument, supported by his extensive experience in both military and civil practice, yet his teaching failed for a long time to influence surgeons generally, either in his own country or in other parts of Europe.

The principal reason for this appears to have been that the fillet, which was the means still in use for controlling the bleeding during the operation, did not answer its purpose effectually even in the ablest hands : so that the dread of hæmorrhage led most surgeons to prefer the cautery as a more expeditious method than the ligature. We even find Fabricius of Aquapendente repeating, in 1618, Galen's timid doctrine of the danger of amputating through living parts at all ;³ and in 1633 the celebrated Fabricius Hildanus, though describing the ligature, states that the time which it occupies, and the consequent loss of blood, make it suitable only for the robust and plethoric, and declares that he 'cannot sufficiently extol the excellence' of the *cauterium cutellare*, or red-hot knife, by which the orifices of the vessels were sealed while they were divided.⁴

In consequence of this same fear of bleeding, the great object at this period seems to have been to accomplish the work of severance of the limb as speedily as possible,

vinegar is to be used ; but any portion of dressing retained in the wound is said to do mischief by causing inflammation : and on the same principle caustics and other powerful styptics, though very efficient in arresting the bleeding, are prohibited because they produce a crust, which acts like a foreign body. In more severe cases the vessels are to be tied ; and finally, 'when the circumstances do not even admit of this,' the red-hot iron may be used as a last resort.

The only thing that seems to me to give any colour for doubt upon this subject, is the manner in which the ligature is described, '*venæ quæ sanguinem fundunt apprehendendæ, circaque id quod ictum est duobus locis deligandæ intercidendæque sunt* ;' language which seems rather to apply to a partially divided blood-vessel than to one completely severed ; but as the context shows that the ligature, as used by Celsus, was applicable in the majority of cases, and to more vessels than one in the same wound, it can hardly be conceived possible that the practice was restricted to the very rare case of partial division.

Again, there can be little doubt that in drawing down the soft parts over the bone after amputation, Celsus aimed at primary union, the great advantages of which are strongly insisted on in the same admirable chapter on wounds ; but it is certain that he knew that the use of the cautery would have destroyed any chance of union by first intention.

One argument that has been urged on the other side is, that if he had employed the ligature in amputation, it would hardly have been neglected by his successors : but the slowness of the surgeons of the sixteenth and seventeenth centuries to adopt it, in spite of the strenuous advocacy of Paré, with all the advantages of a printed literature, show how little weight is to be attached to this objection. The utter neglect, during the middle ages, of the Celsian method of amputation, and of his simple mode of treating wounds, may also be mentioned as analogous cases.

¹ Sprengel's *History of Medicine*, French translation, vol. ii. p. 81, and vol. vii. p. 312.

² *Galen ad Glauconem*, lib. ii. cap. xi.

³ *Hieronimi Fabricii ab Aquapendente Opera Chirurgica*, pars i. cap. xcvi.

⁴ 'Porro excellentiam hujus cauterii non satis extollere possum.' *Gul. Fabricii Hildani Opera omnia*, lib. de Gangrænâ et Splacelo.

and this was often done without any attempt whatever to provide a covering for the bone. Scultetus, in 1655, depicted the performance of amputation of the hand by chisel and mallet; and Purnannus, in his '*Chirurgia Curiosa*,' written as late as 1696, mentions having seen legs removed by two different surgeons by modifications of a barbarous instrument of the middle ages, a sort of guillotine, 'which, by its great weight and sharpness, cuts at once the skin, flesh, and bones asunder;' but he states that it splintered the bone, and *therefore*, 'all things considered, the ancient way of cutting through the flesh with a knife, and through the bone with a saw, is more practicable, safe, and certain.'¹

As an example of the ordinary practice of the seventeenth century may be mentioned that of Richard Wiseman, Sergeant-Surgeon to King Charles II. A fillet having been tightly applied, for the three-fold purpose of checking hæmorrhage, rendering the limb less sensitive by pressure on the nerves, and steadying the soft parts, which were retracted by an assistant, he carried a crooked knife by a single circular sweep down to the bone, which was divided with the saw at the same level, and the bleeding was arrested by the cautery, or some kind of styptic.²

Thus the mode of amputation employed by the father of British surgery only two centuries ago was precisely that used fifteen hundred years before by the Roman Archigenes. And very unsatisfactory were the results which it commonly afforded. The soft parts were insufficient, even in the first instance, to cover the end of the bone, which was accordingly cauterised, with the object of accelerating its inevitable exfoliation, and in the further progress of the case it tended to become more and more exposed by the contraction of the muscles; and even if the patient survived the protracted suppuration that ensued, he suffered more or less from the inconveniences of what has been called the sugar-loaf stump, being in the shape of a cone, the apex of which was formed by the prominent bone, covered either by a sore which refused to heal, or by a thin pellicle of cicatrix, very liable to abrasion.

A great step towards a better order of things was made in 1674 by the French surgeon Morel, in the invention of the tourniquet,³ which though at first but a rude contrivance, being a stick passed beneath the fillet and turned round so as to twist it up to the requisite degree of tightness, furnished the basis for the greatly improved instrument devised in the early part of the following century by his distinguished countryman, J. L. Petit. This consisted essentially of two metallic plates, which could be separated from one another by means of a screw, so as to tighten a strap which was connected with them and also encircled the limb: and it is upon this principle that the ordinary screw tourniquet is still constructed. From this time forward, except in amputations performed near the trunk, hæmorrhage during the operation ceased to be an object of dread, and surgeons were at liberty to consider other questions besides mere rapidity of execution.

The improver of the tourniquet, and our own great countryman Cheselden, seem to have conceived independently of each other the idea of performing amputation

¹ Purnannus' *Chirurgia Curiosa*, English transl. book iii. chap. xii.

² The ligature, though known to Wiseman, seems not to have been adopted by him. After describing different modes of applying it, in a way that shows pretty clearly that he had not practised them, he writes, 'But the late discovery of the royal styptic hath rendered them of less use. But in the heat of fight it will be necessary to have your actual cautery always ready, for that will secure the bleeding arteries in a moment, and fortify the part against the future putrefaction.'—*Chirurgical Treatises*, book vi.

³ English surgeons might dispute with the French the honour of the invention of the tourniquet. In a work written in 1678, published in 1679, entitled *Curvus Triumphalis e Terebintho*, Mr. James Young of Plymouth gives an account of a similar contrivance, apparently produced independently by himself. He describes it as 'a wadd of hard linen cloth, or the like, inside the thigh, a little below the inguen; then, passing a towel round the member, knit the ends of it together, and with a battoon or bedstaff, or the like, twist it till it compress the wadd or boulster so very straight on the crural vessels that (the circulation being stopped in them) their bleeding, when divided by the incision, shall be scarce large enough to let him see where to apply his restrictives' (p. 30). Further on in the book he states that the same principle is applicable with advantage in amputations of the upper limb. But as he does not inform us how long he had used this expedient before he wrote the account of it, the credit of priority must of course be accorded to Morel.

by 'double incision;' in which the skin and fat were first cut through by a circular sweep of the knife and retracted for about an inch, when the muscles and bone were divided as high as they were exposed.¹

But this, though a great improvement, had only the effect of diminishing the cicatrix without covering the bone;² and Louis, another eminent Parisian surgeon, believed that in the thigh the objects sought might be better attained by dividing all the soft parts at once, and sawing the bone at a higher level. In order to allow the muscles to contract freely when divided, he avoided the use of the tourniquet, and was the first to employ in its place digital compression of the femoral artery at the groin. He pointed out the important circumstance that the muscles on the posterior aspect of the thigh, being divided far from their origin at the pelvis, contract to a much greater extent than those at the anterior part of the limb, which are connected with the bone where they are cut; and he showed that, the soft parts having been severed to the bone by a circular incision and drawn up with a linen retractor, the saw might be readily applied two and a half inches higher up, after the knife had been carried through the attachments of the anterior muscles.³ This method was amputation by double incision on a different principle; and though, in truth, a revival of the practice of Celsus, was not less valuable than the plan of Cheselden and Petit, and seems to have afforded results superior to theirs.⁴

Louis, however, was content if the stump when healed was free from conical projection,⁵ and did not aim at forming a complete covering for the bone. This was effectually done about a quarter of a century later by Alanson of Liverpool, by dissecting up the integuments for some distance and then dividing the muscles obliquely, so that they formed a hollow cone, in the apex of which the bone was sawn 'about three or four fingers' breadth higher than was usually done.' The effect of this was to 'fully cover the whole surface of the wound with the most perfect ease;'⁶ but in the hands of other surgeons the oblique division of the muscles proved to be a matter of considerable difficulty, and the object was accomplished as efficiently and more simply by Mr. Benjamin Bell of Edinburgh⁷ and Mr. Hey of Leeds by a combination of the methods of Cheselden and Louis; or, as Mr. Hey expressed it, 'with a triple incision,'⁸ in which the skin and fat were first divided circularly and dissected up for some distance, then the muscles were cut at a higher level, and these were retracted so as to permit the bone to be exposed and sawn considerably higher. Mr. Hey added the advice to cut the posterior muscles somewhat longer than the anterior, to compensate for their greater contraction; and thus towards the end of last century, 'the circular operation,' as it is termed, may be said to have been brought to perfection.

Meanwhile a different principle had been long before suggested and acted on. So early as 1678, Mr. James Young of Plymouth described 'a way of amputating

¹ It is difficult to determine to whom the priority belongs in this matter. Petit in his posthumous work states, 'Je suis le premier qui ait coupé les chairs en deux temps;' and also, 'J'ai imaginé de couper les chairs en deux temps;' and Dieffenbach, in his *Operative Surgery*, gives 1718 as the date of the introduction of the double incision by Petit. On the other hand, Cheselden as distinctly claims the original idea in the following passage in his notes to Gataker's translation of *Le Dran's Surgery*: 'The thing that led me to do this was what has too often happened—the necessity of cutting off the end of the stump the second time. This operation I proposed to my master when I was his apprentice; but he treated it with neglect, though he lived afterwards to practise it when he had seen me perform it in the same hospital.' This proposal must have been made before 1711, when, at the age of twenty-two, he began to lecture on anatomy.

² This is well illustrated by the drawing of a stump given by Cheselden in *Le Dran's Surgery*, for the purpose of showing the good effects of the double incision.

³ *Mémoires de l'Académie de Chirurgie*, vol. ii. p. 286.

⁴ *Ibid.* vol. iv. p. 60.

⁵ 'L'amputation la plus parfaite est, sans contredit, celle dans laquelle les chairs qui forment l'extrémité du moignon conservent assez de longueur pour se maintenir au niveau du bout de l'os.' *Op. cit.* vol. iv. p. 41.

⁶ Alanson's *Practical Observations on Amputation*, 2nd edit. p. 16.

⁷ Benjamin Bell's *System of Surgery*, 7th edit. vol. vii. p. 260.

⁸ Hey's *Practical Observations*, 3rd edit. p. 527.

large members, so as to be able to cure them *per symphysin* in three weeks, and without fouling and scaling the bone.' The directions given for this method, the 'first hints' of which he says he had 'from a very ingenious brother of ours, Mr. C. Lowdham of Exeter,' are as follows: 'You are with the catling, or some long incision-knife, to raise (suppose it the leg) a flap of the membranous flesh covering the muscles of the calf, beginning below the place where you intend to make excision, and raising it thitherward of length enough to cover the stump; having so done, turn it back under the hand of him that gripes; and as soon as you have severed the member, bring this flap of cutaneous flesh over the stump, and fasten it to the edges thereof by four or five strong stitches.'¹ Eighteen years later, Verduin, a surgeon of Amsterdam, ignorant apparently of what Lowdham had done, provided like him a covering for the end of the stump from the calf; but, instead of cutting from below upwards, and only raising the integuments, he thrust a knife behind the bones at the part where he intended to divide them, and cutting downwards formed a muscular flap, which he afterwards supported by an apparatus devised for the purpose of pressing the cut surfaces together so as to check bleeding without the use of either cautery or ligature.² This machine being complicated and unsatisfactory, was rejected in 1750 by M. Garangeot,³ who, substituting the ligature for it, but retaining in other respects the method of Verduin, brought amputation of the leg to the form in which it is still often practised at the present day.

The same principle was applied to the thigh, in 1739, by Ravaton, of Landau; but instead of one long flap he made two short ones. Having divided all the soft parts circularly, he thrust a knife down to the bone on the anterior aspect of the limb, a hand's-breadth higher up, and cut down to the circular wound; and, having made a similar longitudinal incision behind, dissected up the square lateral flaps thus formed, and sawed the bone where it was exposed at their angle of union, and brought them together after tying the vessels.⁴

Vermale, surgeon to the Elector Palatine, soon afterwards formed the flaps more easily, and of a shape better adapted for union, by introducing a knife at the front of the limb and pushing it round the bone at one side, so as to make it emerge at the opposite point behind, and then cutting a flap of rounded form by carrying the knife in a curved manner downwards and outwards, the same process being repeated on the other side.⁵

The flap operation, performed either by cutting from without inwards or by transfixion, was occasionally employed by various surgeons in the latter half of last century; but found its most strenuous advocate in the late Mr. Liston, and at one time seemed likely to supersede the circular method altogether. Its great merit in those days of painful surgery was its facility and speed; for the flaps were cut with great rapidity, and when they were drawn up by the assistant, the bone was exposed with the utmost readiness at the part where it was desirable to divide it; whereas, in the circular operation, to dissect up the ring of integuments was a somewhat troublesome and tedious process, especially in a limb increasing in thickness upwards like the thigh, and the use of a retractor was often necessary, in order that the saw might be applied at a sufficiently high level.

As regards the immediate results of the two methods, the principal difference between them was that the flaps, when formed by transfixion, contained a large amount of muscle, while the circular mode furnished a covering chiefly from the integument. In this respect the flap operation was at first supposed to have a great advantage, as providing a muscular cushion for the end of the stump. But this opinion was shaken by further experience. The muscular part of the covering, no longer discharging its normal physiological function, degenerates and dwindles, while

¹ James Young's *Currus Triumphalis e Terebintho*, p. 108. A copy of this interesting book exists in the library of the Royal Medical and Chirurgical Society of London.

² *Mémoires de l'Académie de Chirurgie*, vol. ii. p. 244.

³ *Ibid.* p. 261.

⁴ Ravaton's *Traité d'Armes à feu*, p. 405; also *Mémoires de l'Académie*, vol. ii. p. 251.

⁵ *Le Dran's Surgery*, Gataker's translation, p. 431.

the integument tends to become thicker and firmer, so that the ultimate results of the flap and circular operations present no material difference. On the other hand, at the time of the performance of the operation, the method by transfixion has the great disadvantage that the muscular element in the flap is almost always redundant, and has to be tucked back to permit the edges of the skin to be stitched together, the natural result being tension and confinement of discharges and consequent inflammatory disturbance. In the very case in which the flap operation was first employed, viz. in the upper part of the leg, the muscular mass proved very inconvenient from its redundancy when the calf was largely developed; and even under more favourable circumstances the heavy and contractile flap was apt to shift from its position or to drag down the skin of the front of the leg, so as to stretch it on the cut end of the tibia, and induce ulceration. Hence Mr. Liston himself, so early as 1839, preferred in muscular subjects a short posterior flap and an anterior one of the same length, composed of integument only;¹ and in the latter period of his practice he changed this for the following modification of the circular operation, which was also suggested independently by Mr. Syme, and was used by him for many years in all cases of amputation in this situation. The skin and fat are divided by two crescentic incisions with the convexity downwards, so as to form short antero-posterior flaps of the integument, which is then dissected up considerably higher than their angle of union, after which the operation is completed as in the ordinary circular method.² This plan gives essentially the same result as the circular mode, while the raising of the integument is facilitated, and its edges can be accurately adapted to each other without any of the puckering that occurred at the angles of the wound after the old operation; and experience shows that when the soft parts have been divided in this way they are quite as favourably disposed for primary union as when cut more smoothly in the form of flaps.

In the lower part of the thigh also, the presence of the contractile element in the flaps was found to be injurious by increasing the disposition to protrusion of the bone, from the action of the powerful hamstring muscles, cut so far from their origin at the pelvis. Mr. Syme accordingly adapted his modification of the circular method to that situation;³ and I can testify to the sufficiency of the covering which it afforded.

The longer time required for this operation than that by flap was rendered a matter of no moment by the discovery of anæsthesia in surgery, in the year 1846.⁴ Independently of the relief from bodily and mental suffering procured by this great event, it must be regarded as an era in the history of amputation, of at least equal importance with the invention of the tourniquet; because, pain being abolished during the operation, as well as dangerous hæmorrhage, surgeons are now, in the great majority of cases, deprived of all excuse for sacrificing anything, either in plan or execution, to mere rapidity of performance, and are enabled to regard simply what will most promote the two great ultimate objects in amputation—safety to life, and usefulness of the stump.

With regard to the latter object, it was till lately an understood thing that the end of the stump was not adapted for bearing any part of the weight of the body. Being tender from the presence of the cicatrix, it was not allowed by the instrument-makers to touch the artificial limb at all; the apparatus being applied partly to the sides of the stump, but chiefly to some bony prominence resting on the upper edge of the socket—the tuberosity of the ischium when the thigh is concerned, and in the leg the internal tuberosity of the tibia, the head of the fibula, and especially the lower border of the patella.

To this general rule, however, a striking exception was presented by the amputation at the ankle devised by Mr. Syme, in which the bones are divided just above the malleoli, where they present a broad surface for diffusing the pressure over the

¹ Liston's *Elements of Surgery*, 2nd edit. p. 786.

² Syme's *Principles of Surgery*, 5th edit. p. 168.

³ *Ibid.* p. 170.

⁴ See the Essay on ANÆSTHETICS in this work.

integument of the heel turned up to cover them, specially fitted by the character of its epidermic investment and subcutaneous fibro-adipose cushion for bearing the weight of the body, while the cicatrix lies well forward out of reach of pressure. The result is that the patient can stand on the end of the stump as on the natural sole; and when the deficient spring of the arch of the foot is compensated by some elastic material contained in a very simple boot, the limb proves nearly as useful as in its normal condition.

Subsequent experience has shown that similar advantages may be attained to a greater or less degree in stumps formed by amputation higher up the limb. It is easy by proper management to ensure the cicatrix falling out of reach of compression by the end of the bone; and the integument, though tender in the first instance, gradually acquires a brawny and callous character when subjected to regulated pressure, like the skin over the dorsal aspect of the cuboid bone in talipes varus, and thus becomes able to bear the whole or part of the weight of the body according to the breadth of the cut surface of the bone, and the consequent diffusion of the pressure. Indeed, stumps possessing these qualities were occasionally obtained as long ago as the time of Alanson, who, speaking of the condition of a patient on whom he had performed amputation above the ankle by posterior flap, says: 'He has been several voyages to sea, and done his business with great activity. He bears the pressure of the machine totally upon the end of the stump, and has not been troubled with the least excoriation or soreness.'¹ But it is easy to understand why such results were altogether exceptional so long as the covering for the ends of the bones was provided by a posterior flap, which, from the force of gravity and the preponderating power of the posterior muscles over those at the anterior aspect of the limb, must always tend to drop from its original position, and leave some part of the bone to be covered only by cicatrix. And independently of this, in the case of the leg, the tibia being covered in front merely by the skin, a scar placed anteriorly is much more likely to suffer from pressure against the bone than one situated posteriorly. The amputation at the ankle is, indeed, by posterior flap; but the full rounded cushion formed by the cup-shaped integument of the heel renders this an entirely exceptional case. It is plain, therefore, that with reference to fitness of the stump for bearing the weight of the body, preference should be given to an anterior flap, which moreover has the great advantage of allowing a dependent opening for the escape of discharge.

The recognition of the advantages of the anterior flap is due to the labours of two English surgeons, the late Mr. Teale of Leeds and Mr. Carden of Worcester, working independently of each other, and proceeding by different methods. Mr. Teale, who had the priority in publication, formed a long anterior and short posterior flap in the following manner. Having ascertained by measurement the semi-circumference of the limb where the bone was to be divided, he first traced with pen and ink upon the skin four lines of that length; two longitudinal, extending downwards along the sides of the limb, and two transverse, of which one joined in front the lower ends of the longitudinal lines, while the other ran across behind from one longitudinal line to the other at the distance of a quarter of their length from their upper extremities. Two rectangular flaps of very unequal lengths being thus mapped out, he raised them, including the muscles as well as the integuments, by cutting from without inwards, and sawed the bone at their angle of union; then, after tying the vessels, he bent the long anterior flap upon itself, that it might 'form a kind of pouch for the end of the bone,' turning up its lower edge to meet that of the short posterior flap, to which it was carefully adjusted and united by a few points of suture, some stitches being also introduced where the edges of skin met at the sides of the stump.²

Experience with this method has shown that in properly selected cases it gives admirable results; the patient being often able to rest his entire weight upon the end of the stump; and even where this is not fully the case, the distribution of the

¹ Alanson, *On Amputation*, p. 133.

² Teale, *On Amputation*, pp. 34 *et seq.*

pressure between the end of the stump and the bony prominences which formerly alone sustained it greatly increases the comfort and steadiness of locomotion.

Nevertheless it must be admitted that Mr. Teale's operation has serious drawbacks. Precise accuracy of execution being essential to its success, it demands a degree of time and pairs which, under ordinary circumstances, would certainly not be grudged, if really necessary, but which most surgeons would be glad to be saved, and which sometimes, as in the pressure of military practice, could not well be given. Again the cut surface is more extensive than with ordinary modes of amputation, involving a larger number of vessels to secure, and also, under some conditions of healing, a more profuse suppuration. But the greatest objection to this method with a view to its general application is the high division of the bone which would frequently be required in order to form the long anterior flap. This defect is of course most marked when the limb is of considerable thickness at the seat of amputation, and shows itself in its most exaggerated form in the thigh of a muscular subject. Thus in a particular instance, where the development was by no means extraordinary, the dimensions were such that, supposing the anterior transverse incision made at the level of the upper border of the patella, it would have been necessary, in order to preserve Mr. Teale's proportions, to saw the bone eleven inches further up, or full five inches higher than if the modified circular operation had been performed. This would seriously have increased the danger, which is always greater the nearer the seat of amputation is to the trunk,¹ while, in case of recovery, the short stump would have been very inferior in usefulness on account of the slightness of the leverage it could have exerted in controlling the movements of an artificial limb.

The same disadvantage would often be experienced in applying the method to the leg. Near the ankle, indeed, where the limb is small and the anterior flap short in proportion, the operation is comparatively free from this objection. But if the circumstances of the case should render it necessary to amputate higher in the limb, the rapid increase of the thickness of the calf would necessitate a high division of the bone greatly out of proportion to the extent of the injury or disease of the soft parts. In a leg of about average development the amputation at Mr. Teale's seat of election, dividing the bones just below the calf, would require the integuments to be sound to the level of the tip of the internal malleolus. But if the skin happened to be unsound to a quarter of an inch above that level, the bones would have to be divided an inch higher; and a difference of three-quarters of an inch in the skin would involve a loss of two inches of the bones; and again an affection of the integuments implicating less than two inches above the tip of the malleolus would require a division of the bones full four inches above Teale's seat of election. And in the last-named situation, where the calf is thickest, the very long flap, consisting in the greater part of its breadth of skin alone, would be very liable to suffer from sloughing.

From considerations like these some of the staunchest advocates of Mr. Teale's method are now disposed to restrict it to the lower part of the leg and just above the knee, where, by turning to account the integument over the patella, which is not used in ordinary operations, the anterior flap may be made of the requisite length without specially high division of the bone.

Mr. Carden proceeded upon a much more simple plan, forming a rounded anterior flap of integument only, without any posterior flap, and retracting the soft parts somewhat from the bone before dividing it with the saw; 'thus forming a flat-faced stump with a bonnet of integument to fall over it.'² This practice he began as early as 1846, nine years before Mr. Teale first employed his rectangular operation; and though refraining from publication, he obtained from that time forward most admirable results, both in safety to life and the amount of pressure that could be borne by the end of the stump.

It was principally at the knee, where amputation had not previously been much

¹ This principle has been pithily expressed by Dieffenbach in the words 'zollweise steigt die Gefahr.' (*Operative Chirurgie*, vol. ii. p. 822.)

² See *On Amputation by Single Flap*. By Richard Carden, F.R.C.S., &c. p. 6. This is a reprint of an article in the *British Medical Journal*, April 1864.

practised, that Mr. Carden applied his principle. The operation at this situation is thus described by him. 'The operator, standing on the right side of the limb, seizes it between his left forefinger and thumb at the spots selected for the base of the flap, and enters the point of the knife close to his finger, bringing it round through skin and fat below the patella to the spot pressed by his thumb; then turning the edge downwards at a right angle with the line of the limb, he passes it through to the spot where it first entered, cutting outwards through everything behind the bone. The flap is then reflected, and the remainder of the soft parts divided straight down to the bone: the muscles are then slightly cleared upwards and the saw is applied,' through the bases of the condyles. 'Or the flap may be reflected first, and the knee examined, particularly if the operator be undetermined between resection and amputation. In amputating through the condyles, the patella is drawn down by flexing the knee to a right angle before dividing the soft parts in front of the bone; or if that be inconvenient, the patella may be reflected downwards.'¹

This operation, when contrasted with amputation in the lower third of the thigh, presents a remarkable combination of advantages. It is less serious in its immediate effects upon the system, because a considerably smaller portion of the body is removed, and also because, the limb being divided where it consists of little else than skin, bone, and tendons, fewer blood-vessels are cut than when the knife is carried through the highly vascular muscles of the thigh; the popliteal and one or two articular branches being, as a general rule, all that require attention, so that loss of blood is much diminished. In the further progress of the case the tendency to protrusion of the bone, which often causes inconvenience in amputation in the thigh, is rendered comparatively slight by the ample extent of the covering provided, and also by the circumstance that the divided hamstrings slip up into their sheaths, so that the posterior muscles have comparatively little power to produce retraction. The superiority of the operation is equally conspicuous as regards the ultimate usefulness of the stump, which from its great length has full command of the artificial limb, while its extremity is well calculated for sustaining pressure, both on account of the breadth of the cut surface of the bone divided through the condyles and from the character of the skin habituated to similar treatment in kneeling. Considering therefore that this procedure can be substituted for amputation of the thigh in the great majority of the cases both of injury and disease formerly supposed to demand it, 'Carden's operation' must be regarded as a great advance in surgery.

It is also of great value with reference to the general question of the best mode of amputating in the lower limb. It confirms completely the conclusion which was, indeed, obvious enough from theoretical considerations, that there is no special virtue in the rectangular shape of the flaps advised by Mr. Teale, but that the advantages claimed for his method may be attained by much more simple means.

Nevertheless to extend the method by anterior flap of skin alone to the thigh and leg, as advised by Mr. Carden, does not seem to me judicious. A flap of integument alone, sufficiently long to cover the entire diameter of the limb, must be liable to the risk of sloughing; and I cannot but think it wise, when the muscular element is available for the purpose, to follow Mr. Teale's example by including it in the composition of the flap. An operation thus intermediate between those of Carden and Teale, with a rounded muscular anterior flap somewhat shorter than Teale's, and compensating for its diminished length and for the absence of a posterior flap by retracting the muscles before applying the saw, was practised in the thigh by Mr. Spence of Edinburgh before Mr. Carden published, and yielded very good results.² But this operation involves as high a division of the bone as Mr. Teale's, and it therefore became an important question whether its advantages might not be attained by some method free from this objection. The essential object to be aimed at is that, while the covering for the bone shall be ample, the tender cicatrix shall be placed sufficiently far back on the end of the stump to be well out of the way of pressure between the end of the bone and the bottom of the socket of the artificial limb. And

¹ *Op. cit.* p. 6.
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² *Edinburgh Monthly Journal*, Nov. 1859,
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if, consistently with attaining this object, the anterior flap could be shortened and eked out with a short posterior flap, it is plain that in exact proportion to the extent to which this was done would be the length of bone gained, with corresponding diminution of danger and increase of usefulness of the stump. Now it fortunately happens, both in the calf of the leg and in the thigh, that the bone lies far forward among the muscles, so that even its posterior surface is considerably anterior in position to the longitudinal axis of the limb. Hence a flap as long as two-thirds of the diameter of the limb would ensure the scar being considerably behind the point of pressure; while a posterior flap half as long as the anterior one would be sufficient to complete the covering. The posterior flap, being short, may be made of integument only, without any risk of sloughing, thus getting rid of the bulk, weight, and contractility of a posterior muscular flap. On the other hand, the anterior flap, being still somewhat lengthy, should be raised so as to contain a good deal of muscle, which will be useful not only by ensuring sufficient vascular supply, but also by increasing the thickness of the cushion below the bone; while any tendency to retraction that it possesses (small compared with that of the posterior muscles) will be counteracted by the force of gravity, through which it will naturally tend to occupy its proper place.

Such was the plan of amputating which I ventured to recommend for the thigh and the calf in the first edition of this work, on theoretical grounds which subsequent experience has only tended to confirm. The details of the method, as applied to these two situations respectively, will be found described in subsequent pages.

Before considering the operations best adapted for particular cases of amputation, it will be well to allude in a general way to the necessary instruments, and the mode of using them.

The amputating knife should have a straight and strong back, and a sharp point, near which the edge should present a gentle convexity. In the old circular amputation, a curved knife with a blunt extremity was employed to divide the integument at one continuous sweep; but as the modified operation is always preferable, in which the skin is cut in the form of short semilunar flaps, this somewhat clumsy implement may now be entirely dispensed with. For a flap operation performed by transfixion, the blade should be about half as long again as the diameter of the limb; but when the soft parts are cut from without inwards, a much shorter knife will answer the purpose, and should therefore be preferred, as the movements of the smaller instrument can be directed with greater precision and speed. For removing a finger or toe, something intermediate between the tapering bistoury often used in France and the old round-bellied English scalpel will be found to combine the advantages of both, without the inconveniences of either, being equally adapted for piercing and cutting.

In using the knife, the young practitioner will have to unlearn some of the habits he has acquired in anatomical study. The object being now simply to divide the resisting textures efficiently, the stroking and scratching movements of the dissecting-room must be changed for a free sawing motion: and for this purpose the knife must be held firmly in the hand, instead of being kept in the feeble position best suited for the investigation of delicate structures.

There is another error to which the habits of dissection may lead, far more serious than a cramped and awkward use of the knife, viz. that of directing the edge of the instrument towards the skin in raising a flap of integument. Such a practice, necessary in anatomy, in order to leave the subcutaneous structures intact, will, if carried into amputation, most seriously endanger the vitality of the flap, which derives its supply of nourishment from vessels ramifying in the fat, and must perish if those vessels are extensively divided through scoring of the *tela adiposa*. I am satisfied that integument designed to form a covering for the stump is often made to slough for want of scrupulous attention to this simple point.

The skin should always be cut perpendicularly to its surface, for if it is bevelled off to a thin edge, it is not only unsuited in shape for adaptation with a view to primary union, but the margin may slough for lack of nutriment.

In transfixing a limb, the direction of the knife must of course be changed as it passes round the bone, in order that it may emerge at the opposite aspect ; but it is desirable that this should be done in a continuous manner ; for if the instrument be thrust in for a certain distance, and then partially withdrawn and made to follow a new track, the punctured wound first made may cause very troublesome hæmorrhage, if a considerable arterial branch happen to be divided in it.

In passing the knife round a bony prominence, such as the shoulder, care must be taken to hold the limb in such a position as shall relax the parts that are to be pierced, otherwise what might be quite easy may prove impossible ; and in the latter part of the process, when the point of the knife is advancing in a greatly altered direction, it is important to keep the back rather than the edge directed outwards, in order to avoid cutting the base of the flap.

In amputating at a joint, if the tissues are healthy, the division of the soft parts completes the process, there being no need to take away the articular cartilage, which is almost as favourably circumstanced for healing as vascular structures. Thus, when a finger is removed at the metacarpo-phalangeal joint, the whole wound may unite by first intention ; or if suppuration occurs, the cartilage undergoes a change into granulations by a process so speedy as hardly to delay the cure.

The saw, for dividing the bone in other cases, should be broad-bladed, with a stout back, like the 'fine saw' of the carpenter, and should have small but well-set teeth. In applying the instrument, its heel being placed upon the bone, previously cleared of soft parts by a circular sweep of the knife, it should in the first instance be drawn with firm pressure towards the operator, so as to make a groove which it will have no disposition to quit in the first forward stroke. The bone is thus cut precisely at the place desired.

The assistant who holds the limb must take care not to press it forcibly upwards, otherwise the saw will become locked ; nor must he draw it downwards to any great degree, or the bone will break and splinter towards the last. But the operator should always be so placed as to be able to control with his left hand the part which he removes. Should any projecting portion be left, it must be removed with a pair of bone-pliers, which may be substituted entirely for the saw when the bone is of very small size, as in the fingers. In using them, the flat surface should always be directed towards the parts that are to be preserved, as the other sides of the wedge-shaped blades crush the bone while they divide it.

The tenaculum, long universally employed for seizing the bleeding vessels in order to tie them, has been superseded by the catch-forceps, which, like the bone-pliers, were introduced into surgical practice by the late Mr. Liston. Besides being always more convenient, they have the great advantage of making the surgeon independent of an assistant in cases of emergency. The ligature should be tightly and securely tied, by reversing in the second half of the knot the relation that the ends of the thread had to one another in the former half, or, in the language of sailors, by making a 'reef-knot.' The larger arteries should be drawn a little way out of their sheaths, as the best means of avoiding nervous trunks and other unnecessary tissue. The principal veins also should be tied ; the dread of exciting phlebitis by such treatment having proved entirely groundless. As regards smaller vessels, the old rule was to tie only such as furnished a distinct pulsating stream. But as the catgut ligature with short-cut ends has none of the inconveniences of the long threads of silk or flax formerly employed, there is now no objection to tying mere oozing points, however numerous ; and this practice has the great advantage that it banishes all risk of reactionary hæmorrhage.

The catgut, of course properly prepared to fit it for surgical purposes, should be used of as slender quality as will bear the strain of tying ; except in the case of advanced atheroma, when the finer kinds may be found to cut through the degenerated tissues of an arterial trunk, and a thicker sort must then be employed for the principal vessels. If the ligature cannot be made to hold when applied round the point of the forceps in the usual way, as when fibrous tissue is condensed by inflammatory infiltration, the difficulty may always be overcome by threading a fine

curved needle with catgut with both ends long, and passing it so as to take a substantial hold of the tissues at the site of the bleeding point, cutting off the needle, and tying the two pieces of gut one at each side. The bleeding vessel will be sure to be included in one of them.

Torsion is preferred by some surgeons; but, though it is admirable for many wounds, particularly about the face, those who have tried both in amputation will, I think, agree that the ligature is more unfailing and on the average more expeditious.

In the second edition of this work I recommended a practice which I had adopted for some years with great advantage, viz. raising the limb into the vertical position and pressing it firmly from the extremity towards the trunk with the view of emptying it of venous blood, and then tightening as rapidly as possible a screw tourniquet, previously kept perfectly loose. The contrast between the 'almost bloodless' division of the tissues under such circumstances and the gush of venous blood which attended the operation when the tourniquet had been applied in the horizontal or dependent position of the limb was extremely striking. Soon afterwards Professor Esmarch of Kiel published his bloodless method, which consisted of forcing the blood out of the limb by means of an elastic bandage applied continuously from the distal extremity to a point some distance above the site of the intended operation, and then applying another elastic band just above, to serve as a tourniquet and maintain the bloodless condition when the continuous bandage was removed. By these means the limb is rendered absolutely ex-sanguine at the seat of operation.

There can be no doubt of the great advantage of the upper elastic band, which follows up any yielding of the soft parts and maintains continuously a perfectly effective constriction; whereas with the common tourniquet, if the operation was protracted, and especially if the tissues were unusually yielding through inflammatory or œdematous infiltration, the inelastic strap had to be further tightened again and again in consequence of recurrence of bleeding. Esmarch's elastic tourniquet has thus entirely superseded the old instrument. But for emptying the limb of its blood the method of elevation seems to me preferable, if it is used in such a way as to obtain its full advantages, with a view to which it is essential to understand the *modus operandi*. Though I first employed elevation, as others had occasionally done before me, with the object merely of emptying the limb of its venous blood, I saw before long that much more than this was really done. If the elevated position was maintained for a sufficient length of time, the perfectly blanched appearance of the skin implied that arterioles as well as veins were emptied in a manner that could not be accounted for on merely hydraulic principles by the effect of gravity upon the blood; and being led to inquire into the matter experimentally, I ascertained that when a limb is raised, the first effect of gravity in emptying and relaxing the veins is followed by a gradual contraction of the larger as well as smaller arteries of the limb under the influence of the vasomotor nervous system; the effect reaching its maximum in about four minutes.¹ If, therefore, the limb is kept raised to the utmost for about that length of time, care being taken not to press upon any part containing a venous trunk, and the elastic tourniquet is then rapidly applied, a degree of bloodlessness of the site of operation is obtained which is practically as good as that of Esmarch's method, while it is free from two objections which attend the latter. One of these is referred to by Esmarch, viz. that it is inapplicable in case of putrid infiltration of the tissues, on account of the risk of forcing septic matter into the interstices of sound tissues; and I may add that I should feel considerable hesitation in applying the continuous elastic bandage to a part affected with soft malignant tumour, fearing the possibility of the disease being diffused by the upward pressure through venous or lymphatic channels. The method by position, on the other hand, is applicable to all cases. The other objection to Esmarch's method which many surgeons have complained of, and which has induced some to

¹ See an Address on the Influence of Position on the Local Circulation, *Brit. Med. Journal*, June 21, 1879.

abandon it, is a liability to reactionary hæmorrhage. From this also the method by position is free. Esmarch's original elastic band, consisting of a tube of caoutchouc about as thick as the finger, or a somewhat thinner solid rod of the same material, is, I believe, the best for the thigh; because, while it is exceedingly effective, the abrupt constriction which it produces cannot injure the nervous trunks, well protected as they are by an abundant padding of muscles. But in the case of the arm, where the soft parts are comparatively scanty in proportion to the bone, serious paralytic effects have followed the use of the elastic tourniquet in this form. These are, however, entirely avoided by employing for the upper limb, in accordance with Von Langenbeck's suggestion, a flat elastic bandage, the pressure of which is more diffused. The elastic tourniquet, whichever form is used, should be put well on the stretch, and wound quickly three or four times round the limb to ensure efficiency of its action. The elastic bandage is fixed by means of a pin; the rod or tube by tying in a bow pieces of stout tape previously well secured to its extremities. This may be done very simply by tying the tape very tightly round the end of the tube or rod bent into a loop, which cannot escape from the grasp of the ligature.

The only inconvenience attending the elastic tourniquet as compared with the old instrument is that it cannot be relaxed and tightened at pleasure to show the bleeding points, but must be removed once for all. In practice, however, this difficulty is overcome by searching for the principal arteries in the places indicated by anatomical knowledge, and, when these have been secured, tying all points from which any venous blood oozes, by which means the vein and its accompanying artery will be both included. When this has been done, it will often be found that not a single vessel requires attention when the constricting band has been removed. But to guard against the chance of any having escaped notice, the main artery of the limb must be subjected to digital compression.

The strength of the assistant on whom this duty devolves is often early exhausted by unnecessary exertion; for the current through an artery lying over a bone, or some other resisting texture, is completely arrested by a very moderate amount of pressure directed exactly to the proper part.

A stump after amputation is dressed on the same general principles as other wounds. When there is much tendency to muscular contraction with its attendant risk of protrusion of the bone, as in the lower part of the thigh, this disposition is greatly checked and repose of the stump promoted by a bandage applied smoothly and moderately firmly from above downwards, while an assistant draws down the soft parts. In the thigh and also in the leg great advantage is derived from bandaging upon the posterior surface of the stump outside the dressing a trough of Gooch's splint on which the stump rests smoothly, being rendered independent of movement or irregularity of the pillow. The end of the stump should not be much raised, as too great elevation interferes with free discharge, and increases through gravity the tendency to retraction of the soft parts.

AMPUTATIONS IN THE UPPER EXTREMITY.

The upper limb, independently of its smaller size, and the consequent less shock to the system from the operation, is more favourably circumstanced for amputation than the lower, in consequence, apparently, of its possessing a better vascular supply and superior vital power. Thus, it is a more serious thing to amputate a toe than a finger, and to take away the arm at the shoulder-joint is a much safer proceeding than to cut off a leg below the knee, even though a larger wound be inflicted, and a larger portion of the body removed, in the former case than in the latter. The more advanced in life the patient is, the more do these differences show themselves. But if circumstances admit of the septic element being effectually excluded, such considerations have comparatively little of the weight formerly attached to them.

The particular amputations in the upper extremity will be most conveniently considered in the order in which they occur from below upwards. The distal phalanges, though very liable to injury and disease, rarely require amputation; for

the removal of crushed portions of bone in the former case, or exfoliation in the latter, will generally leave a useful end to the finger. If it be wished, the phalanx may be readily taken away by opening the joint across its dorsal aspect, and, after getting the knife round the base of the bone, forming a palmar flap, by cutting from within outwards. Or the palmar flap may be first cut by transfixion; and this being held up by an assistant, the operation is completed by cutting straight through the articulation. If the whole distal phalanx be crushed, amputation through the second phalanx will be best performed by cutting from without inwards two rounded lateral or antero-posterior flaps, and dividing the bone with pliers.

Removal of the entire finger is generally preferable to leaving the first phalanx by itself, which, besides being unseemly, would be a mere incumbrance, except in the index-finger; and even there it is of service only in some few handicrafts. For the middle, or the ring-finger, the operation is best performed according to the following definite rule. The adjoining fingers being held aside by an assistant, the surgeon cuts from the prominence of the knuckle in a straight line towards the middle of the web on one side; but, just before reaching the web, carries the knife inwards to the fold between the finger and the palm, and, after making a similar incision on the other side, accomplishes the disarticulation. The edges of the skin will be found to meet exactly on approximation of the adjoining fingers, which should be kept tied in that position, to avoid disturbing the process of union. Remarkably little deformity results from this operation, so that removal of the head of the metacarpal bone for the sake of appearance is quite uncalled for. If, however, it is at any time necessary on other grounds to take away a portion of the metacarpal bone, this can be readily done by the same method, except that the incisions are made to start from the place on the back of the hand where the bone is to be divided by the cutting pliers.

The index-finger may be removed in a similar manner, care being taken, in making the incision on the side next the thumb, to carry the knife from the point of the knuckle in a longitudinal direction to near the level of the web between the fingers, before sloping it off towards the palm, otherwise the flap will be insufficient to cover the raw surface. A preferable method, however, is to make dorsal and palmar flaps of rounded form, by cutting from the web between the fingers to a point on the opposite side of the articulation at a sufficiently high level to allow the end of the metacarpal bone to be taken off obliquely with pliers, so as to get rid of what would cause an unseemly prominence. But if it be necessary to remove a considerable portion of the metacarpal bone, the former method, with the dorsal part of the incision extended upwards, will be the best.

Similar rules apply to the little finger; and, in cases requiring it, the whole metacarpal bone may be removed, by commencing the incision a little above the articulation with the *os unciniforme*, so as to give space for dividing the ligaments after clearing the bone of the muscles which surround it.

Any portion of the thumb is valuable for opposition to the fingers; but, if necessary, the whole of it may be taken away by cutting in a curve, with the convexity downwards, from the web connecting it with the forefinger to the opposite side of the joint, both on the dorsal and palmar aspects, raising the rounded flaps, and disarticulating. The whole metacarpal bone may be removed along with the thumb on a similar plan, by entering the knife a little above the articulation with the trapezium, and cutting first longitudinally, and then with a gentle curve to the web, on each side of the bone, then dissecting up the flaps, and dividing the ligaments of the joint.¹ This operation has been often performed for tumour of the metacarpal bone; but from a case published by Mr. Syme, it would appear that under such circumstances a useful thumb may be preserved by excising the bone affected.²

¹ For removing the thumb or little finger with the metacarpal bone, other modes of operating, somewhat more rapid, but in other respects disadvantageous even when applicable, were recommended before the introduction of anæsthesia. At present, it appears only necessary to mention such as are calculated to give the best results.

² *Observations in Clinical Surgery*, p. 38.

The thumb alone or a single finger, being far more useful than any substitute, should always be retained if possible in cases of injury ; an artificial hand being afterwards used, provided with a claw, against which the single digit left may be pressed so as to hold objects firmly.

Amputation at the wrist-joint may be performed by cutting across the back of the wrist from one styloid process to the other, in a line presenting a slight concavity downwards, in accordance with the form of the articulation, opening the joint on its dorsal aspect, then shaping a rounded flap in the palm, raising it to the joint, and disarticulating. Another method is to cut the palmar flap from within outwards after disarticulation ; but the prominence of the pisiform bone prevents this from being satisfactorily accomplished.

Amputation in the forearm may be performed by antero-posterior flaps. In front, where the muscles are in larger amount, transfixion may be adopted ; but behind, the presence of the two bones prevents this, except near the wrist, where it may be effected, provided the soft parts have their natural laxity, by pinching up the skin, and passing the knife as close to the radius and ulna as possible, when, after the integument has fallen back to its usual position, the extremities of the wound will be placed so far forward that the knife can be introduced through them in forming the anterior flap. But it is probably always well to cut the dorsal flap from without inwards, and to raise it so that it shall consist chiefly of integument, in order that redundancy of muscle and consequent tension may be avoided. The surgeon standing on the (patient's) left side of the limb, and holding it with the dorsal surface towards him, enters the knife a little to the palmar side of the bone that is the further from him, and cuts through the skin and fat so as to shape a rounded dorsal flap, terminating the incision a little to the palmar side of the nearer bone, where he at once pushes in the point of the knife, so that it may pass in front of the bones and emerge at the place where the operation was commenced, and cuts a fleshy palmar flap from within outwards. He then dissects up the dorsal flap ; and the soft parts being drawn back by an assistant, clears both bones thoroughly about three-quarters of an inch higher up, and applies the saw. The interosseous artery, which is apt to retract beside the unyielding interosseous membrane, must always be secured as well as the radial and ulnar trunks ; and if the median or ulnar nerve is exposed in the palmar flap, it should be shortened with scissors, to prevent the occurrence of painful symptoms as the stump heals.

There is no objection to amputation at the elbow-joint, in cases adapted for it. The most eligible plan is to cut a large anterior flap from within outwards, after transfixing the partially-extended limb in front of the joint, bearing in mind that the line of the articulation is oblique to the axis of the humerus, and is considerably further below the internal than the external condyle. The flap being then held up by an assistant, the points of transfixion are connected posteriorly by a semicircular stroke of the knife, which, besides dividing the integument, probably detaches the radius, and a few touches with the point of the instrument will sever the connections of the ulna. The assistant should keep the skin of the back of the arm drawn upwards during the operation.

Amputation of the arm presents a good example of the double-flap operation by transfixion. The point of the knife being entered at one side of the limb, avoiding the site of the brachial vessels and nerves, is pushed on in front of the bone ; and then, by slightly raising the handle, is made to emerge at a place exactly opposite. The anterior flap is then cut with a brisk sawing movement of the instrument, which is first directed longitudinally for a short distance, and then turned gradually towards the surface, and brought out perpendicularly to the integument. The flap is now lightly raised by the assistant, without any traction, for this would interfere with transfixion behind the bone, which is effected through the extremities of the wound already made, and the posterior flap is cut like the anterior. The assistant now retracts the flaps firmly, when a circular sweep of the knife exposes the bone about an inch above the angle of union of the flaps, and another similar turn of the instrument prepares it for the application of the saw.

The edges of the wound meet accurately when brought together, producing a symmetrically rounded stump. But when the muscles are largely developed, it is well to avoid the inconvenience occasioned by their redundancy, by cutting the flaps from without inwards, or by employing the modified circular method.

Amputation at the shoulder-joint is an operation which yields very satisfactory results, as was strikingly shown by the experience of the late Baron Larrey, who, during the wars of the first Napoleon, saved ninety out of a hundred cases, in spite of the very unfavourable circumstances of military practice.¹

Of the various methods that have been proposed, that of Lisfranc is the most expeditious. The arm being raised so as to relax the deltoid, the point of a long-bladed knife is introduced about midway between the coracoid and acromion processes, and thrust round the outer side of the joint till it comes out within the posterior fold of the axilla (or, if the left limb be the subject of operation, the direction of transfixion is reversed), when a large muscular external flap is rapidly cut; and this being held up by an assistant, and the arm drawn downwards and forwards, the joint is opened by cutting firmly upon the head of the bone,² which is then raised from its socket so that the knife may be passed round it, and carried downwards along the inner surface of its neck and shaft, followed by the other hand of the assistant, which grasps the tissues that lie between the track of the instrument and the axilla, so as to prevent bleeding from the main artery, when it is divided in the completion of the short internal flap.

This operation, however, is rarely available in practice. Its satisfactory performance requires the leverage of the humerus, which is generally broken in cases of injury demanding removal of the limb, in which also the parts necessary for the large external flap are often encroached on; and in tumour of the bone, which is the other affection that most frequently calls for amputation in this situation, transfixion becomes inadmissible.

On the other hand, Larrey's mode of operating, by lateral flaps of equal size, proved almost always applicable in his cases of gunshot wound, while it was as secure against hæmorrhage as that of Lisfranc. Thrusting the point of a knife of moderate length down to the bone immediately below the acromion process, Larrey first made a longitudinal incision about two inches in length, from the extremity of which he cut in a curved line at each side of the limb to the fold of the axilla; then dissected up the muscular flaps so as to expose the articulation completely, a finger of an assistant being placed upon the divided circumflex artery; and, having severed the connections of the head of the humerus, passed the knife round it, and kept the instrument close to the inner side of the bone, till, turning the edge towards the surface, he last of all divided transversely the tissues intervening between the axillary folds, containing the artery, previously commanded by the hand of the assistant following the knife.³

This operation is improved by dividing the structures between the folds of the axilla obliquely, as part of the internal flap, the lower portion of which is reserved to be cut from within outwards, at the conclusion of the operation: the result being two precisely similar semilunar flaps, meeting above at the acromion and below at the posterior fold of the axilla, adapted for immediate union throughout their length, and presenting as small a wound as is consistent with an efficient covering.

When the bone is broken near the joint, it will be found useful to adopt Mr. Syme's expedient of introducing the finger into a longitudinal wound in the capsule, for the purpose of drawing down the head of the bone so as to gain access to its

¹ *Mémoire de Chirurgie militaire*, par le baron D. J. Larrey, tome iv. p. 434.

² Strictly speaking, this is Dupuytren's modification of the method of Lisfranc, who depressed the arm at the commencement of the operation, and opened the joint during the transfixion; but this was a less easy proceeding, though shorter by a few seconds in very expert hands.

³ During one period of his practice, he formed the lower parts of the flaps by transfixing from the end of the longitudinal incision to the borders of the axilla, and cutting from within outwards; but the method given in the text is that to which he ultimately gave the preference. See Larrey's *Clinique chirurgicale*, 1829, p. 563.

attachments. In some cases of tumour it may be necessary to raise all the soft parts, including the axillary vessels, from without inwards; when hæmorrhage must be restrained by compression of the subclavian artery over the first rib, by the thumb of an assistant pressed down behind the collar-bone.

Sometimes it may be best to make a large superior flap, cut from without inwards, containing the whole width and chief length of the deltoid muscle; but circumstances will often arise in which no regular rule can be followed, and the parts that happen to be sound must be turned to the best advantage, according to the judgment of the operator. Even when a large raw surface is left, the granulating process will complete the cure, as is well illustrated by some of Larrey's cases, which terminated satisfactorily after extensive loss of the soft parts of the shoulder and removal of portions of the scapula.

AMPUTATIONS IN THE LOWER EXTREMITY.

The distal phalanx of the great toe may be removed in the same way as that of a finger. When one of the smaller toes is in a condition requiring amputation at all, it should be taken away entirely, since any portion left would be likely to prove inconvenient from being tilted upwards. The operation is exactly similar to that for a finger; but it must be borne in mind that the articulation with the metatarsal bone, which is the starting-point for the incisions, is much further behind the web than the corresponding joint in the hand, in proportion to the size of the digit.

When the whole great toe is removed, or the little toe, the prominent part of the head of the metatarsal bone must be cut off by an oblique application of the bone-pliers, as it would prove inconvenient if left. The longitudinal part of the incision in the soft parts should be placed on the dorsum of the foot, to avoid the inconvenience that might arise from pressure on a scar at the lateral aspect. In amputating the great or little toe, together with the whole metatarsal bone, it is best to proceed as in the analogous operation for the little finger, the incision being commenced on the dorsum of the foot, about a quarter of an inch behind the articulation with the tarsus, and carried longitudinally to near the metatarso-phalangeal joint, where it bifurcates to embrace the root of the toe. The knife, which should be a strong one, is then applied with a short sawing action close to the metatarsal bone and its articulation with the toe, so as to clear them completely; and the ligamentous attachments of the base of the bone are lastly divided with the point of the instrument. In the case of the great toe, it is especially important to keep the knife well under command, and avoid thrusting its point deeply into the sole; for this, besides inflicting unnecessary punctures, may wound the plantar artery at a part difficult of access. This mode of removing the great or little toe and its metatarsal bone, though not so rapid as that of dissecting up a flap from the side of the foot, then cutting between the toe to be removed and the adjoining one, and disarticulating, has the great advantage of avoiding any scar in the sole.

If more metatarsal bones than one require removal, the incision must be begun in the same way, but made to include the roots of all the toes concerned, so as to form a dorsal and a plantar flap; and even in case of caries in the articulation between the tarsus and metatarsus at one side, a useful foot may be left after taking away the bones affected, by means of a similar incision commenced further back.

The separation of the whole metatarsus from the tarsus is an operation seldom called for; but it is evident, from the account given by the late Mr. Hey, of Leeds,¹ who introduced it, that it affords excellent results. When the state of the soft parts permits, the ends of the exposed tarsal bones should be covered with a long flap from the sole, turned up to unite with the dorsal integument, cut very short; so that the cicatrix, being on the upper part of the foot, may be out of the way both of pressure in walking and of contact with objects in front of it. In performing the operation, it must be remembered that the tarso-metatarsal articulations are not in a regular line, but that the base of the second metatarsal bone is locked between the first and third cuneiform bones, of which the former is the more prominent, and is connected

¹ Hey's *Observations*, p. 555.

laterally with the second metatarsal by a very strong interosseous ligament. To divide this ligament, Lisfranc adopted the plan of thrusting an amputating knife obliquely downwards and backwards between the first and second metatarsal bones into the substance of the sole, the tissues of which served as a fulcrum, supporting the point of the instrument, when its edge was urged forcibly between the bases of the bones by pushing the handle backwards. This, however, is a needlessly rough proceeding; for by pressing firmly back between the bases of the bones a strong and short knife, such as ought to be used for the rest of the operation, the ligament may be cut without difficulty; after which all the articulations are readily separated by scratching through the dorsal and other ligaments with the point of the knife, while the metatarsus is strongly depressed.

The secret of facility in the operation lies in hitting the line of the articulations; but this is readily enough done by finding first the joints of the first and fifth metatarsal bones, and bearing in mind that the others lie in a line between them, slightly convex forwards, interrupted by the recession of the second bone. The prominence of the base of the fifth metatarsal indicates the situation of its joint, and, if the parts be in a natural condition, the articulation of the first metatarsal with the first cuneiform can also be felt. Should inflammatory thickening obscure the position of the latter, it might be well to measure the distance of the corresponding joint from the internal malleolus on the sound foot; or assistance may be derived from the circumstance that the joint lies midway between the malleolus and the metatarso-phalangeal articulation.

These points having been precisely ascertained, the surgeon grasps the fore part of the sole with his left hand, placing the tip of the forefinger at one of the joints, and the thumb at the other, to mark their position, and cuts firmly across the dorsum of the foot in a line slightly convex forwards, a little anterior to the articulations, taking care that the incision commences and ends fairly in the sole. He then opens the joints of the first and fifth metatarsal bones, so as to ensure finding the line of the articulations afterwards, and next shapes a long plantar flap by an incision extending from the extremities of that already made along the sides of the foot and roots of the toes, dissects up the flap from the bones, and completes the disarticulation in the manner above described.

When the anterior part of the sole is unsound, a shorter plantar flap and a proportionally longer dorsal one may be made, as recommended by Sir Astley Cooper.¹

Sometimes the proceeding may be greatly simplified by sawing through the metatarsal bones a little anterior to their bases, and so avoiding disarticulation altogether. This method would probably have another advantage, from making the stump of the foot longer and therefore a more effectual lever for opposing the muscles which act upon the calcaneum through the tendo Achillis; for experience has shown that when the foot is much shortened, the heel is apt to be drawn up, so as to cause the end of the stump to point more and more towards the ground, producing lameness or entire inability to walk. This has been noticed especially after Chopart's amputation through the tarsus, which is consequently an undesirable operation, even in cases of injury: while in caries it is further objectionable, because the part of the tarsus left behind, though apparently sound at the time, may become affected with the same disease at a later period.

If it be wished, however, Chopart's operation may be performed on the same principle as Hey's, by making a very short dorsal flap, and a plantar one reaching to the balls of the toes, to cover the exposed anterior surfaces of the astragalus and os calcis. The articulation between them and the navicular and cuboid bones will be found in a line running across the foot, through a point midway between the external malleolus and the base of the fifth metatarsal bone.

In the amputation at the ankle devised by Mr. Syme, the bones of the leg are divided just above the bases of the malleoli, a covering for the osseous surfaces

¹ *Surgical Lectures*, edited by Tyrrell, vol. ii. p. 432.

being provided from the integument of the heel ; the result being a stump admirably fitted for bearing the weight of the body. At the same time, the parts likely to originate carious disease are completely got rid of ; so that this operation is calculated to supersede entirely that of Chopart, besides taking the place of amputation of the leg in the majority of the cases formerly supposed to demand it.

The operation should be performed as follows. Provision being made against hæmorrhage by the pressure of the thumb and finger of an assistant, placed respectively on the middle of the fore part of the limb and behind the tibia, about two inches above the joint, so as to control the anterior and posterior tibial arteries, or by an elastic tourniquet above the knee, and the foot being held at right angles to the leg, the surgeon puts his left hand behind the heel, with the finger and thumb on the places where the incisions are to commence and terminate ; these being the tip of the external malleolus and the point exactly opposite on the inner side, *i.e.* not at the tip of the internal malleolus, but considerably below and behind it. With a knife, short and strong both in blade and handle, he now cuts down to the bone across the sole, from one of these points to the other, in a plane either vertical or sloping slightly towards the heel when that part is unusually prominent ; and then, extending the foot, joins the horns of this incision by another running as straight as possible across the front of the ankle. He next dissects up the posterior flap from the os calcis, keeping the edge of the knife close to the bone with the guidance of the left thumb-nail, till the point of the calcaneum is fairly turned, when he proceeds to open the joint in front, divides each lateral ligament with a stroke of the knife applied between the malleolus and astragalus, and completes the removal of the foot by severing the tendo Achillis. He then prepares the bones of the leg for the application of the saw ; taking care, when cutting behind the tibia, to keep close to its surface, from which the posterior tibial artery is separated only by a little loose cellular tissue ; and lastly, he takes off the malleoli along with a slice of the intervening part of the tibia, sawing exactly perpendicularly to the axis of the limb—that is to say, directing the saw vertically and transversely while the leg is kept horizontal.

It is a common mistake to make the inner end of the incision at the internal malleolus, instead of opposite the extremity of the outer one. This has two bad effects : it renders the flap unsymmetrical, and, what is far worse, it makes it unnecessarily long, and thus introduces an element of difficulty and risk into an easy and safe operation. For when the incision is carried forwards into the hollow of the foot, it becomes a most troublesome task to turn back the integument over the prominence of the heel ; and the knife being thrust the operator knows not where, the subcutaneous tissue containing the vessels on which the skin depends for its nourishment is punctured and scored, and perhaps the point of the instrument itself appears occasionally through the skin itself, while the flap is subjected to violent wrenching in the effort to draw it back over the bony projection. Under such a combination of unfavourable circumstances, it is but natural that it should slough.

On the other hand, when the flap has been made as above directed, in accordance with the latest recommendations of the author of the operation,¹ it applies itself with perfect uniformity to the surface it is designed to cover, and has no disposition to shift to one side in the after progress of the case ; and every stroke of the knife by which it is raised being made under the eye of the surgeon, without any forcible traction, it is as little liable to slough as any other portion of integument with an equally broad base and an equally rich vascular supply. Even the integrity of the posterior tibial artery, though desirable, is by no means essential, provided the rest of the subcutaneous tissue has been left uninjured. Many persons, in discussing the merits of this operation, seem to assume as an axiom that sloughing of the flap must occasionally take place ; but I am persuaded from very extensive experience that, if the skin of the heel be sound, such an occurrence will always be the fault of the surgeon.

Hence the various modifications of the original method that have been suggested, though commonly discussed chiefly with reference to a fear of sloughing, must be

¹ See Mr. Syme's Clinical Lectures in the *Lancet*, 1854.

judged of entirely on other grounds. Thus the plan introduced by the late Dr. Richard Mackenzie, of Edinburgh, of making the base of the flap at the inner side, that it may have a more free supply of blood from the posterior tibial artery, is not to be regarded as a substitute for the simpler method of a posterior flap; yet it proves useful in case of unsoundness of the integument on the outer side of the heel; and it is probable that an external flap might be made with equal advantage if the internal aspect of the limb were affected. At the same time it may be worth while to remark that the mere presence of sinuses at either side is no ground for deviating from the original procedure; and, further, that no degree of complication of sinuous tracks ought to induce the surgeon to amputate in the leg and deprive his patient of the greatly superior stump afforded by Syme's amputation.

The operation of the late Professor Pirogoff, of Petersburg, in which the posterior part of the os calcis is sawn off and turned up as part of the flap, to unite with the cut end of the tibia, has the disadvantage in cases of caries that it entails a risk of recurrence of disease in the portion of the calcaneum remaining. It is also more complicated than Mr. Syme's method, from the necessity of accurate adjustment of the osseous surfaces, with a view to the best position for the posterior flap. For this purpose both bones are cut obliquely; the tibia in a plane looking somewhat backwards as well as downwards, and the os calcis in one that is directed somewhat upwards as well as forwards; so that when the cut surfaces are applied to each other, the dense plantar integument covering the lower part of the calcaneum is presented downwards for supporting the weight of the body, rather than the thin skin over the posterior aspect of the bone. If these points are attended to, Pirogoff's amputation gives a thoroughly useful stump in cases of injury. But I am not aware that it has any advantages over that provided by Syme's operation, and the increased length of the stump which it produces is rather objectionable than otherwise; for with the original operation, the space afforded for the artificial foot is not more than the maker finds convenient.

When the ankle-joint is affected with caries, the saw should be applied at a higher level than usual to the tibia and fibula, and the vertical articular surfaces by which the joint is continued upwards between those bones should be removed with cutting pliers, to guard against recurrence of disease in that situation.

In cases which do not admit of Mr. Syme's operation, amputation immediately above the ankle should be performed if possible, in preference to that at 'the seat of election,' a little below the knee; for, although the use of the knee-joint may be retained even with a very short stump, the longer one gives greater command over the artificial limb, and the operation involves less risk to life.

Different methods may here be employed. One mode is to make a short semi-lunar anterior flap cut from without inwards, and a large posterior one formed by transfixing behind the bones and cutting downwards and outwards, the saw being applied a little above the bases of the flaps; or antero-posterior skin flaps of equal length may be made, and the bones divided somewhat higher up. Or again, the modified circular operation¹ is applicable in this situation.

But the method by longer anterior flap is greatly to be preferred to any other, on account of the excellent covering it affords, with the cicatrix out of the way of pressure, enabling the stump to sustain the whole or a considerable part of the weight of the body on its extremity. The principles on which the operation should be performed have been already fully discussed in former pages,² but a modification of the plan there indicated is called for on account of the difficulty of retracting the soft parts from the bones. This arises especially from the intimate attachment of the muscles to the fibula; but if these are divided through an extension upwards of the outer longitudinal incision, no difficulty is experienced, unless the tissues are condensed by inflammatory thickening, in effecting retraction of the remaining soft parts from the tibia without dividing the skin at the inner side to a higher level than the typical operation demands. Another point requiring special attention in the leg, as compared with the thigh, is the raising of the anterior flap. The anterior tibial

¹ See p. 702.

² See p. 706 *et seq.*

artery, on which the flap depends for its nutrition, lies close to the interosseous membrane, and would be very liable to be punctured during the dissection if we did not follow Mr. Teale's advice in conducting it. He pointed out that in consequence of the looseness of the cellular connections of the interosseous membrane, there is no difficulty in separating the parts in front from its surface with the finger-tip, while dividing with the knife the attachments of the muscles to the bones.¹ In this way, the vessel is secured from any chance of injury.

Immediately above the ankle the operation is performed as follows. The diameter of the limb having been ascertained by spanning it, a straight longitudinal incision of that length is made at the inner side of the leg, and on the outer aspect another similar incision directly over the fibula and extending about an inch higher up. The lower ends of these incisions are connected by cutting across the front of the limb in a direction transverse in the main, but rounded off where it joins the lateral lines. The knife is next carried round the back of the limb to the bones from the upper end of the internal incision to a point exactly opposite on the outer side, which will be about an inch below the upper end of the outer incision; the instrument being carried in a line slightly convex downwards, so as to form a very short posterior flap. The anterior flap is then raised in the manner above mentioned, including everything in front of the bones and interosseous membrane; after which the tibia and fibula are cleared as high as the level of the upper end of the outer incision, the finger-tip being still used in detaching the parts anterior to the interosseous membrane.

In order to avoid splintering the fibula, it is best to saw both bones at the same time, and to finish the fibula before the tibia. The sharp angle of the spine of the tibia being apt to cause ulceration of the skin over it, should be removed; and the most convenient way of doing this is to commence with sawing obliquely for a short distance from a point about half an inch above the place where the bones are to be divided transversely. Supposing effectual antiseptic treatment employed, the cutaneous margins of the flaps may be stitched very closely, except at the upper end of the outer incision, which is left open for the drain, and serves admirably for the purpose, as it leads directly from the cut surfaces of the bones, and is dependent in position from the circumstance that the limb reposes on its outer side. Accurate stitching is desirable elsewhere, in consequence of the disproportion of the sizes of the two flaps, which, however, is diminished by making a short posterior flap as advised.

In amputating through the calf on the same principle, the operation is similar, except that, for reasons before discussed,² the anterior flap need not be longer than two-thirds of the diameter of the limb; but, to compensate for its diminution, the posterior flap must be made at least half as long as the anterior, by carrying the knife round the back of the limb at an angle of forty-five degrees through the integuments, and dissecting them up to the level of the upper end of the inner part of the incision, before cutting towards the bones, so as to get rid of the heavy and contractile mass of the sural muscles.

The old flap operation is still employed in the calf by many surgeons, being very readily accomplished by drawing the knife in a segment of a circle across the front of the leg from one bone to the other, transfixing behind them, and cutting first downwards and then gradually outwards, next dissecting up the anterior flap of integument, and clearing and dividing the bones at the level of its base. But it is, as we have seen,³ a most undesirable proceeding, on account of the bulk of the muscular mass from the calf turned up to cover the ends of the bones. Mr. Spence met this objection by shaving off a considerable portion from the face of the posterior flap after forming it. But though this was undoubtedly a great improvement, it could not give to the operation the advantages of the method by longer anterior flap.

When there is not enough sound integument to admit of the latter method, the modified circular operation of Mr. Syme⁴ proves highly valuable, enabling us to form out of the smallest amount of materials a short stump, which is preferable to any that

¹ See *Medical Times and Gazette*, July 6, 1861.

³ See p. 702.

² See p. 706.

⁴ See p. 702.

can result from operating higher up in the limb, the patient either retaining the use of the joint or resting his weight with great security and comfort upon the bent knee.

The great merits of Mr. Carden's amputation through the condyles of the femur have been already fully discussed.¹ I cannot but agree with him that the patella should always be removed. In cases of injury it may seem a tempting thing to leave it, sawing off its articular surface, that it may unite with the divided end of the femur; but having tried this plan before Mr. Carden published, I have found that while it *may* result in an admirable stump, it is sometimes attended with serious inconvenience, from the patella being tilted up from its proper position by the action of the quadriceps extensor. Besides this, the presence of the patella interferes with the adequacy of the covering for the end of the femur, and makes it needful to borrow more integument from the front of the leg than is otherwise requisite. And as regards the ultimate result, when the sawn extremity of the femur has been rounded off by ossific deposit, it proves little, if at all, inferior to the patella for bearing the weight of the body. The only objection to Carden's operation, as described by him,² is the occasional occurrence of more or less sloughing of the long anterior flap of skin, in spite of faultless operating. It is plain that the risk of sloughing would be diminished if the flap could be made shorter by not carrying the horns of the incision by which it is formed so high up the limb; and on making experiments on the dead body several years ago, to ascertain to what extent this could be done without disadvantage, I found that it is by no means difficult, when the parts are in their natural condition, to accomplish the operation without making any anterior flap at all, the integuments in front being divided transversely at the level of the lower end of Mr. Carden's flap. I also found it advantageous to form a short posterior skin-flap, both for the sake of coaptation of the cutaneous margins without puckering, and as a useful addition to the covering for the end of the stump.

With this modification, the operation is performed as follows. The surgeon first cuts transversely across the front of the limb from side to side at the level of the anterior tuberosity of the tibia, and joins the horns of this incision posteriorly by carrying the knife at an angle of forty-five degrees to the axis of the leg through the skin and fat. The limb being elevated, he dissects up the posterior skin flap, and then proceeds to raise the ring of integument as in a circular operation, taking due care to avoid scoring the subcutaneous tissue; and, dividing the hamstrings as soon as they are exposed, and bending the knee, he finds no difficulty in exposing the upper border of the patella. He then sinks his knife through the insertion of the quadriceps extensor, and having cleared the bone immediately above the articular cartilage and holding the limb horizontal, he applies the saw vertically and at the same time transversely to the axis of the limb (not of the bone), so as to ensure a horizontal surface for the patient to rest on. The popliteal artery and vein are then secured, and any articular or other small branches that may require it.

When the soft parts are thickened and condensed by inflammation, the integuments cannot well be reflected above the patella with such incisions of the skin. But the difficulty may be got over by cutting into the joint as soon as the ligamentum patellæ is exposed, and at once removing the leg by dividing the ligaments and hamstrings; after which the soft parts can be retracted from the femur sufficiently to permit the application of the saw. The arteries having then been secured, the patella is dissected out at leisure.

As thus performed, Carden's operation takes a little more time and pains than when the integument is divided in the form of an anterior flap; but these are well rewarded by the ample covering for the bone, the small external wound, and the perfect security against sloughing.

Some surgeons speak highly of amputation through the knee, leaving the articular portion of the femur and the patella, a covering being provided by forming a large anterior and short posterior skin flap from the leg, the result being that the patient rests his weight upon the broad rounded end of the bone while the patella is drawn

¹ See p. 705.

² *Ibid.*

up by the quadriceps to occupy the hollow between the condyles in front.¹ There can hardly, I think, be two opinions as to the superiority of Carden's method to this procedure for carious disease of the knee-joint; and in cases of injury, when the integuments are sound as far as five inches below the patella, which is the length of the long anterior flap according to the method hitherto recommended,² a satisfactory though very short stump may be made below the knee. But from my experience with Carden's operation I feel sure that the amputation through the knee may be much improved by dividing the integument in the circular fashion, slightly modified to permit neat adjustment of the cutaneous margins, in which case it would not only be freed from the risk of partial sloughing of the anterior flap which is admitted by its advocates,³ but, the posterior integument being made to take a larger share in forming the covering, it would not be needful to go so far down the limb in front, and thus the operation would become available for cases of injury reaching too high in the limb to permit amputation below the knee. And in order to ensure complete adequacy of the covering, the saw might be carried through the middle of the articular end of the femur so as to flatten it without interfering with its breadth, and thus in all probability improve rather than impair the fitness of the end of the stump for bearing the weight of the body. On this matter, however, I cannot as yet speak from personal experience.

In amputation of the thigh, if we except cases in which the soft parts are affected at one side only, where a covering may be advantageously provided from the sound side, the flaps should always be antero-posterior, because, the flexor muscles being no longer counteracted by the weight of the limb, the bone tends to become tilted forwards, so that its extremity would be apt to show itself in the anterior angle of lateral flaps.

In the lower half of the thigh, the method by longer anterior flap, on the principles before considered,⁴ will be found easy of execution and excellent in results. Two straight incisions are made through the skin and fat along the lateral aspects of the limb, parallel to its anterior surface, and equal in length to two-thirds of its diameter, and their inferior extremities are connected in front by a straight transverse cut, curved upwards near its ends to join the longitudinal ones, so as to shape out a moderately long rectangular flap with rounded angles, if we may so speak. The knife is then passed round the back of the thigh at an angle of forty-five degrees to its axis, marking out a short posterior skin flap, which is at once dissected up, the limb being well elevated by an assistant. The anterior flap is next raised so as to contain a moderate amount of muscle, and the soft parts being well retracted, the knife is swept circularly through the muscles, so as to expose the bone for the application of the saw about two inches above the angle of union of the flaps.

The incisions should always be made as far down in the limb as the state of the soft parts permits; and the skin over the patella, if available, will be employed with great advantage as part of the anterior flap.

For restraining hæmorrhage the elastic tourniquet must be applied as high as possible in the thigh, and if its constriction is found to interfere with the due retraction of the soft parts, it is best to saw the bone in the first instance where it is easily reached, and, after securing the vessels and removing the tourniquet, expose the bone at the requisite level, and saw off an additional portion, held steady with a pair of strong forceps.

When digital compression is resorted to, the hands should grasp as much of the circumference of the limb as possible, while the thumbs are placed one above the other over the vessel, as it lies on the pelvis, midway between the symphysis pubis and the iliac spine.

Even in the upper part of the thigh, although the object of having a stump capable of bearing weight upon its extremity is no longer to be considered, the operation above described will be found to yield better results than that by trans-

¹ See especially a paper on Amputation at the Knee-joint, by Mr. Pollock, *Medico-Chirurgical Transactions*, 1870.

² See Mr. Pollock, *ibid.*

³ *Ibid.*

⁴ See p. 706.

fixion, by avoiding the redundancy of muscle which is the great defect of the latter method. Nor need this plan involve greater loss of blood. For the posterior flap, being only cutaneous, can be raised without material bleeding; and the anterior flap, after being shaped by carrying the knife through the skin and fat, may be completed by transfixion, while comparatively little retraction of the soft parts is required, in consequence of the short-cut muscles having little tendency to cause protrusion of the bone. Moreover, all bleeding during the performance of the operation may be effectually prevented by the elastic band applied in the manner to be described in connection with the next amputation.

Amputation at the hip-joint has of late years been divested of much of the danger that formerly attended it; so that it now ranks among the well-established operations of surgery.

What may be termed the classical method is to form a large anterior flap by transfixion, disarticulate, and cut a short posterior flap, also from within outwards. The thigh being somewhat fixed, to relax the soft parts of the front of the limb, the point of a knife with a blade fully a foot in length is entered midway between the anterior-superior spinous process of the ilium and the great trochanter, supposing the left side operated on, and passed in front of the bone till it emerges near the tuberosity of the ischium, or in the opposite direction if the right limb be concerned. The knife is then carried longitudinally with a rapid sawing movement, followed by the fingers of one hand of an assistant, which are introduced into the wound so as to compress the femoral artery securely between them and the thumb, previously placed over it in the groin, his other hand being employed to lift up the large anterior flap as soon as it is completed. The limb being now extended and abducted, the surgeon opens the capsule of the joint by cutting firmly upon the head of the bone; and as this starts from its socket, he divides the round ligament and the posterior part of the capsule; and lastly, the thigh having been adducted, to draw the trochanter down out of the way of the knife, he completes the severance of the limb by cutting downwards and backwards through the muscular mass at the back of the thigh.

Attention is now at once directed to the bleeding vessels of the posterior flap, fed by the internal iliac, which are covered in the first instance with a folded cloth, or, what is better, by the tips of the fingers of an assistant; and when they have been tied the femoral trunk and any of its branches which may require it are secured in the anterior flap.

But though I have described this mode of operating, captivating as it is by its brilliant swiftness of performance, I do not desire to recommend it. Many years ago I was much impressed with a circumstance that I witnessed in the practice of one of my colleagues in Glasgow. He amputated below the trochanters by antero-posterior flaps for malignant sarcoma of the lower part of the femur; but the part of the bone removed being examined after it had been sawn longitudinally while the vessels were being secured, the disease was found to extend up to the part where it had been divided in the amputation. The surgeon therefore seized the remainder of the femur with powerful forceps and dissected it out from its socket. This was done with great facility and with scarcely any loss of blood; and it occurred to me that, if the same procedure were adopted when it was intended from the first to disarticulate, shock, which is one of the great dangers of amputation at the hip-joint, would surely be greatly diminished; for we could not suppose that the powerful impression produced upon the nervous system by that operation performed in the usual way could be due either to the removal of the head of the bone or to the mere extent of the cut surface as such. The correctness of this view has been since strikingly demonstrated by the practice of Mr. Ferneaux Jordan of Birmingham, who, in cases suitable for such a procedure, first divides the soft parts circularly low down in the thigh, and then dissects out the bone from among the muscles and from the acetabulum through a long incision on the outer aspect of the limb, where the soft parts are comparatively thin and the blood-vessels inconsiderable; a long boneless stump being the result. Now such an operation

involves both disarticulation and the formation of an exceedingly extensive wound ; yet Mr. Jordan's anticipations of increased safety of this method as compared with the old one seem to have been fully realised. Ever since the Glasgow experience to which I have referred, I have myself proceeded on the principle which it suggested ; and while it does not seem to me necessary to push it to the extreme degree advocated by Mr. Jordan, I would advise the following as the method to be generally adopted.

Supposing the right limb operated on, the knife is entered at the posterior part of the great trochanter and carried down longitudinally for about eight inches (if the patient be an adult male), and then drawn across the limb in front and behind through skin and fat, in the form of two crescentic incisions which meet at the inner side of the limb at a point an inch or two lower down than the extremity of the outer longitudinal cut. The semilunar flaps mapped out by the crescentic incisions are then dissected up as in a modified circular operation, the integument being raised about two inches higher than their angle of union at the inner side of the thigh ; after which the muscles are divided where they are exposed and the head of the bone dissected out.

Such a mode of operating, besides the diminished danger from shock, has the great advantage of making truly aseptic treatment easy, instead of almost impossible as it is when the copious sero-sanguineous discharge which takes place from so large a wound is poured out within a very few inches of the anus, which is the case after the ordinary operation, with the dependent angle of the wound close to the tuberosity of the ischium. After the operation which I have advised, the inner end of the wound having been closely stitched and drainage-tubes introduced at its outer part, there is sufficient space for an effectual antiseptic dressing, which will often be a matter of life and death where so large an extent of irritable and absorbent surface is concerned.

The longer time occupied by the operation is of no consequence now that we have the means of dealing efficiently with the once dreaded hæmorrhage. For this purpose I advised in former editions of this work the use of the aortic tourniquet. This instrument, however, has two defects. In the first place, when the aorta deviates to any considerable extent from its normal median or nearly median position, the tourniquet is somewhat difficult of adjustment, and instead of retaining its position by the clamping action of the screw which presses down the pad, it tends to slip to one side on the rounded body of the lumbar vertebra, and must be held in place by a very careful and steady assistant. And, in the second place, an inexperienced or nervous surgeon may be tempted to screw down the rigid instrument with needless violence and damage the intestine by so doing.

Mr. Davy of the Westminster Hospital has suggested a very ingenious mode of compressing the common iliac artery by introducing into the rectum one end of a smooth wooden cylinder two feet in length and about an inch in diameter passed in sufficiently far to permit it to be pressed down upon the vessel on the brim of the true pelvis when the other end or handle of the instrument is carried to the thigh of the opposite side, and then raised so that the rod may act as a lever for which the anus serves as a fulcrum.¹ In most cases in which Davy's lever has been employed it has answered to admiration.² But it is intelligible that in case of a short mesorectum it might be impossible without undue force to effect compression of the iliac trunk on the right side ; and of course if the coats of the rectum were unsound, the instrument would be wholly inapplicable. Accordingly I lately heard of a case in which a gentleman specially conversant with the use of the lever failed to bring it into effective action ; and another case has been mentioned to me where death resulted from mischief done by the end of the rod working in the dark.

Hence I believe it to be wiser to adopt here also the principle of Esmarch's elastic compression. It may be applied either to the aorta or to the extreme upper

¹ See *Brit. Med. Journal*, May 18, 1878.

² See Mr. Pearce Gould, *Transactions of Clin. Soc. of London*, 1879.

part of the limb. For the aorta a pad of sufficient size, such as a pincushion, adjusted over the vessel about the level of the iliac crests, is pressed down by elastic bands, which, however, ought not to encircle the body directly and so cause inconvenient constriction of the waist, but should be connected with the ends of a rigid object placed transversely beneath the back and extending laterally sufficiently far to protect the sides of the body from compression. A narrow piece of board with two lateral notches at each end would answer the purpose quite well for an emergency as a substitute for the curved piece of stout iron with rings or hooks at the ends recommended by Esmarch.

When the elastic band is applied to the *limb* for amputation at the hip-joint, special arrangements must be adopted to keep it well out of the way of the knife, and also to prevent it from slipping down and becoming useless when the support of the head and neck of the bone is withdrawn by disarticulation. The following method will be found to answer perfectly. An elastic band having been provided sufficiently strong to require the full force of the surgeon to stretch it to twice its length,¹ and long enough to encircle the upper part of the limb when in the relaxed condition, and with tapes securely connected with its ends, is placed with one end of the elastic part under the sacrum, while the tape of that end is brought round the pelvis between the crest of the ilium and the great trochanter of the side opposite to that to be operated on, and held perfectly firmly in the vertical position by an assistant. The surgeon then, standing on the side for operation, puts the band fully on the stretch in a direction transverse to the body and brings it up into the vertical position immediately below the iliac crest. Holding it in his left hand (if the right limb is concerned) he next passes his right hand round behind the limb, which has been previously placed in the vertical position to expel its blood, and changing hands encircles the thigh as near to the perinæum as possible, the scrotum being held well to the other side by an assistant. The surgeon's end of the elastic band being now over the groin, he takes the other tape from his assistant and ties the two tapes together in a reef bow over the sound side. Another point requires attention. Two pieces of bandage, each about two feet in length, are placed longitudinally upon the skin before the elastic band is applied, one of them over the groin, the other well behind the great trochanter; the middle of each piece of bandage being in the situation where the elastic band is to go. And when the elastic band has been applied, the lower end of each of these pieces of bandage is drawn up so as to convert them into two loops by means of which, in the hands of a steady assistant, the elastic tourniquet is kept drawn well up both at Poupart's ligament and behind the trochanter. If this arrangement is well carried out, the whole operation, including disarticulation, may be done uninterruptedly. Nevertheless I think it prudent to retain the resistance of the head and neck of the femur so long as the tourniquet is in operation, by sawing through the bone below the trochanters, and at once securing all the vessels that show themselves on the cut surfaces. The tourniquet is then removed while an assistant compresses the femoral at the groin: and when any branches still requiring attention have been tied, the remainder of the bone is seized with strong forceps and dissected out. With the incisions which have been recommended this will be found a matter of the utmost facility and attended with little if any hæmorrhage.

JOSEPH LISTER.

¹ About three of the ordinary rods of red caoutchouc, placed side by side and tied together at their ends, will be found to answer the purpose for an adult.

AMPUTATION.

PART II.

ARTIFICIAL LIMBS.

THE invention of substitutes for amputated limbs has taxed the ingenuity of surgeons and instrument-makers for ages, and, though great advances have been made, but few apparatuses have been constructed which can make up for the loss of

FIG. 153.—Artificial Arm for Agricultural Labourers.



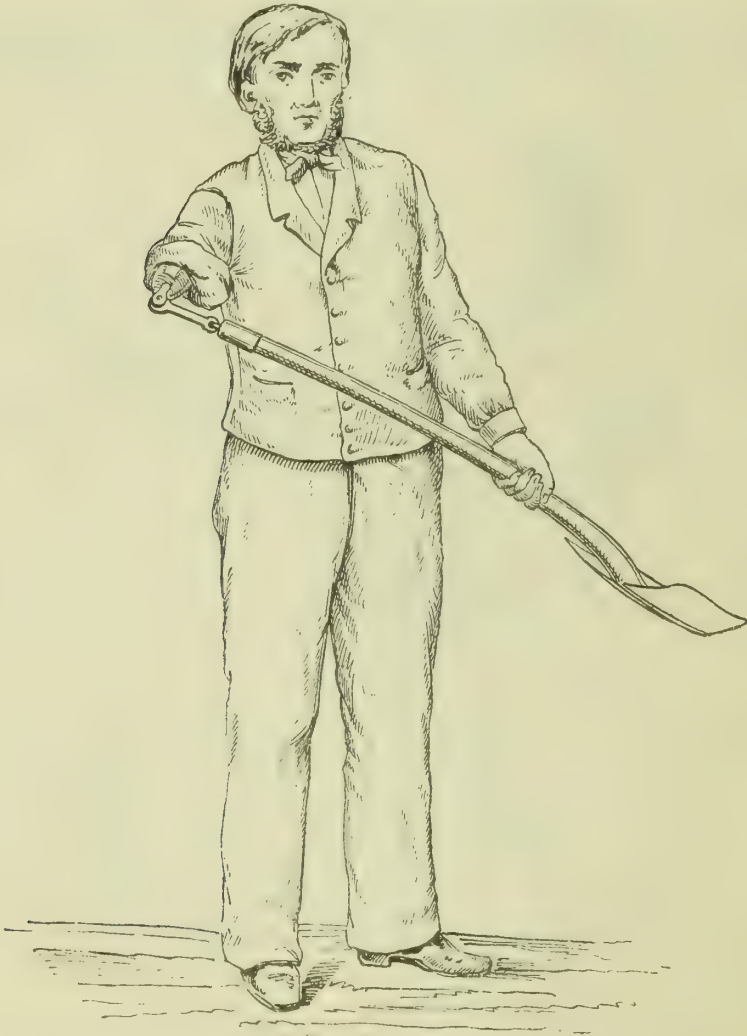
the natural limbs or restore even a moderate amount of usefulness. This is more especially the case with the upper extremity, where it is a matter of great difficulty to make an artificial hand which shall possess some of the natural movements, and at

the same time have strength sufficient to render it serviceable to the artisan. It is not my intention, nor have I sufficient space at my disposal, to enter into a discussion of the numerous forms of apparatus which have been from time to time introduced; but I shall very briefly indicate what are the principles on which the most successful attempts have been made, and mention one or two instruments which seem to be useful.

UPPER EXTREMITY.

Here the forms of apparatus differ according to the seat of amputation; and the amount of usefulness restored depends on whether the hand alone has been removed,

FIG. 154.—Artificial Arm for Agricultural Labourers.



or whether amputation has been performed through the forearm, upper-arm, or at the shoulder-joint.

In the case of workmen the attempt to provide an artificial hand with moveable fingers is seldom made, and where the hand or forearm has been amputated, an apparatus is fitted on the stump into which various implements—such as a hook, a knife, fork, &c.—may be fastened by means of screws or clamps. This does not require any special description.

Where amputation has been performed above the elbow-joint, the best form of

substitute in the case of a labourer has a joint at the situation of the elbow, as is shown in the accompanying figures (figs. 153 and 154). In this case the arm is surrounded by a leather cap, which is strapped to the stump and kept in its place by bands which pass under the other axilla. At the lower end of this sheath is a cone of wood into which an iron rod is fixed, this rod rotating freely around its axis. The iron rod completes the length of the upper-arm, and at the situation of the elbow forms a hinge-joint with a second bar. The lower part of this bar has the form of a prong, into which the necessary implements (a spade, pick-axe, &c.) can be fastened. By means of this simple arrangement flexion and extension are obtained at the elbow-joint, while rotation takes place higher up, and thus a great measure of usefulness is

FIG. 155.—The 'Workman's Arm' of the Société Française de Secours aux Blessés.



restored to the patient. In some cases it is convenient to have an additional joint in the bar which represents the forearm.

Other forms of instruments acting on the same principle have been constructed, and are useful in certain cases (see fig. 155).

The attempts to provide an artificial limb with movements resembling the natural ones have resulted in the construction of many ingenious instruments, which are of value to those who possess an independent fortune, and do not require to employ the artificial hand for heavy work. An apparatus has, however, been constructed for amputation at the wrist-joint, which restores the normal movements of the fingers to a surprising degree, and which enables the wearer to do a great deal of even heavy

work. I take the description from Max Schede's work on amputation (see figs. 156-159).

The apparatus is made in the main of German silver, suitably padded, and consists of a case for the upper-arm (fig. 156, A), and a part enclosing the forearm (fig. 156, C), which are united by hinge-joints at each side of the elbow-joint. A surrounds the upper-arm closely, C is so wide that the movements of pronation and supination may be freely performed in it. This portion C is connected with the hand by a sort of ball-and-socket joint: provision being made for rotatory movement, and also for flexion and extension of the wrist. These movements are brought about by means of the other hand, and the joint can be fixed in any position by the knob K (fig. 156). The lower end of the forearm is closely surrounded by a leather sheath (fig. 156, D). The fingers move as a result of the pronation and supination of the forearm. Attached to the lower part of the sheath D is a screw with wide threads, which runs in a nut (female screw) in the middle of the wrist-joint. In its course this screw passes through a metal plate (fig. 157, m), which moves upwards and downwards with the movements of the screw in the nut, *i.e.* with pronation and supination. To this plate *m* metal rods which go to the proximal ends of the first phalanges of the fingers

FIGS 156, 157, 158, 159.—Artificial Hand after Amputation at the Wrist.

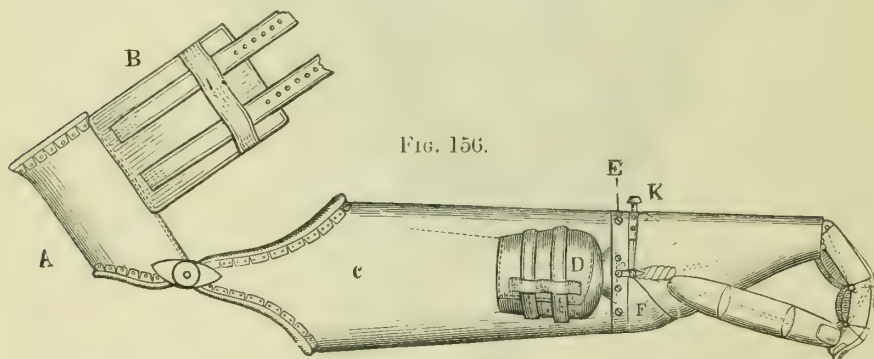


FIG. 156.

FIG. 157.

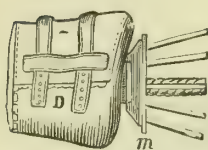


FIG. 158.

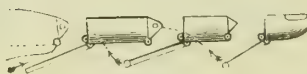


FIG. 159.



are articulated by small hinge-joints. The mode in which the other phalanges are bent as the result of the flexion of the first phalanx will be at once evident from a study of figs. 158 and 159. When the arm is pronated the plate *m* is drawn upwards, and the fingers are bent with the same amount of force as was exercised in pronating the arm. Thus the degree of pressure on any object grasped is at once evident to the wearer; and another advantage of this apparatus, not possessed by any other so far as I am aware, is, that flexion and extension of the fingers can be carried out with equal facility in the flexed or extended positions of the elbow. An amount of true usefulness is thus obtained which no other artificial limb has as yet given.

Movement of artificial fingers has been brought about in various other ways, but the power thus exercised is very slight, the movement only occurs along with a corresponding movement of the elbow-joint, and there is but little tactile power, if we may so call it—I mean the power of judging of the degree of force with which any object is grasped. Indeed, in the earlier forms, the movements were purely passive, in some cases a rack and spring arrangement being used, so that while the fingers remained fixed in any position of flexion in which they were placed, they immediately became extended by means of a spring when a lever was touched. Sometimes in these artificial hands the fingers are kept flexed by means of springs, while

catgut bands pass down from the front of the upper arm and are so arranged as extensor tendons that when the elbow is stretched out the fingers are extended. In other instances, the movements have been obtained partly by springs and partly by catgut attached to the opposite shoulder, extension of the fingers being brought about by forward movements of that shoulder.

Where amputation has been performed above the elbow the usefulness of the hand is very slight. Several very ingenious forms of apparatus have, however, been constructed, in which the movements of the elbow-joint have been brought about by forward or backward movements of the same or opposite shoulder or of the pelvis, the movements of the fingers being obtained on similar principles. In some cases the movements of pronation and supination have also been to some extent restored. Even in the case of amputation at the shoulder-joint a certain amount of movement has been obtained from movements of the pelvis.

The success of these attempts depends in the main on the length of the stump, the great principle in amputating through the upper extremity being to leave as long a stump as possible, every inch saved increasing very greatly the usefulness of the artificial substitute. The other characteristics of a good stump have been referred to in previous articles, the chief points being painlessness and a scar not adherent to the end of the bone.

LOWER EXTREMITY.

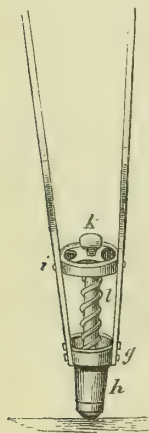
The earliest and still the most common substitute for the lower extremity is the stiff wooden or cork leg. These are preferred in most cases where the patient has hard work or much walking to do, for they form a much more stable support and are used with greater ease and less fatigue than limbs with moveable joints. In fitting these limbs the most important thing to attend to is the point of support for the weight of the body. With very few exceptions, no weight ought to be borne by the end of the stump. The only cases in which this can be done are after disarticulation, or after Carden's amputation at the knee-joint, and Syme's and Pirogoff's amputations at the ankle. In no other amputations must the weight of the body be transmitted to the end of the bone.

In cases where the foot and portion of the leg have been removed it was formerly the custom to walk on the tuberosity of the tibia, which rested on the padded upper end of the wooden leg, the knee being kept constantly in the bent position. Hence the origin of the term 'amputation at the seat of election'—the seat of election being that point where the stump would not project too far backwards, or, on the other hand, be too short to afford a satisfactory basis for support. In this arrangement the artificial leg has a prolongation upwards on each side, which is securely fastened to the thigh by means of straps. The performance of amputations through the leg at the seat of election has now been given up in most cases, as it has been recognised that a moveable knee-joint is of great importance to the patient, and that for this purpose the longer the leg up to a certain point the better.

Where amputation has been performed through the upper part of the thigh or at the hip-joint, the weight of the body is always transmitted to the artificial limb by means of a ring on which the pelvis rests; but in the case of amputations lower down, opinions differ greatly. Some carry the support to the pelvis in all cases, even where amputation has been performed through the lower part of the leg, while others get their support on the sides of the thigh, even where the amputation has been through the femur. In the case of amputation through the femur, there can, however, be little doubt that it is better to transmit the weight of the body through the pelvis, for if the sides of the thigh alone be depended on, the dragging of the skin must be very apt to produce a conical stump, or to increase conicity, if it already exists. And, further, as the case must be made to fit accurately, so as to distribute the pressure equally, and as the stump will be constantly undergoing changes in size and shape, the case will require constant alteration. The inconvenience which will arise from retention of sweat under the case, though of secondary

moment, must also not be overlooked. The advantages claimed for the support on the side of the thigh are that it is more elastic than in the case of the pelvis, and that there is less shaking of the body in walking and less halt. In cases where the support is carried to the pelvis, the weight is transmitted through the tuber ischii or the horizontal ramus of the pubis, or even through a more extensive surface.

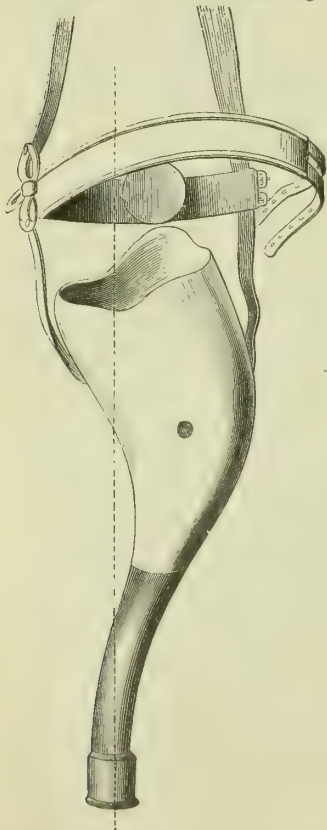
FIG. 160.—Wooden Leg with Spring.



In the case of the leg we have an additional point of support in the tuberosities of the tibia, and probably for most amputations through the leg, at least for those through the lower part, a combination of the tuberosities of the tibia and the sides of the thigh as fixed points is the best.

Many improvements have been made in the shape of the lower end of the old wooden leg which have greatly increased its usefulness, and must be briefly indicated. Formerly the lower end consisted simply of the piece of wood of which the rest was composed, made broader, and sawn off at right angles to its long axis. In taking a forward step with this leg the pelvis is raised, the stump swings outwards, and there is an entire absence of elasticity in the walk. To remedy these defects various alterations have been made in the shape and structure of the lower end. Some have applied an india-rubber ball over it; others have added a convex wooden or cork sole; while in some cases a spring has been placed above the convex and moveable lower end, this spring being slightly compressed by the weight of the body during walking (see fig. 160). This is undoubtedly the best arrangement.

FIG. 161. Curved Wooden Leg.



These wooden legs are generally straight, but when complete extension of the thigh is impossible, the artificial limb has a compensatory curve, as shown in fig. 161.

Of late patients have not been content with a stiff artificial limb, and consequently numerous attempts have been made to provide moveable joints. An intermediate form is much used where the artificial leg is formed so as to resemble the natural limb, but is kept quite stiff during walking, a joint being, however, present which can be bent by means of a spring when the patient wishes to sit down.

Even although the knee is kept stiff, great advantage is obtained without any corresponding loss of firmness by having moveable joints at the ankle and toes. The forms of ankle-joint are extremely various, but essentially consist either of hinge-joints or of ball- and socket-joints. The objection to the ordinary hinge-joint is that it does not permit lateral movement, and therefore the patient cannot stand with his legs apart nor walk on uneven ground. To obviate this inconvenience various devices have been employed, such as the insertion of gutta-percha between the two joint surfaces, which are connected with each other by means of bolts, or other arrangement, permitting such an amount of lateral mobility as is obtained from the elasticity of the gutta-percha. The most usual forms of ankle-joints at the present time are constructed on the ball and socket type, but with

limited mobility, and so fitted with springs that after any lateral movement the foot is at once brought into the straight position when the weight of the body is removed.

An important point in walking is that the toe should be raised as the leg is bent and advanced forwards, so as not to catch the ground. This is done in various ways, as by having the extensor catgut tendons attached above the knee in front, so that when the knee is bent the tendons are pulled on and the toes raised. Another way in which this has been carried out is by placing a spring behind, which is pressed on when the knee is bent and pushes down the heel.

The unfolding of the foot in walking—the elastic power got from the mobility of the toes—is imitated in two ways: either by having an Achilles tendon of catgut or elastic india-rubber material, which is stretched when the knee is straight and offers a resistance to the weight of the body; or by having a joint at the anterior

FIG. 162.

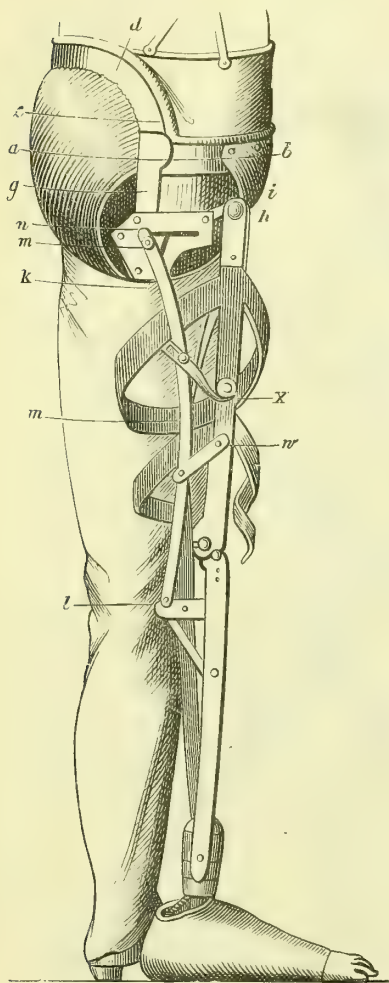
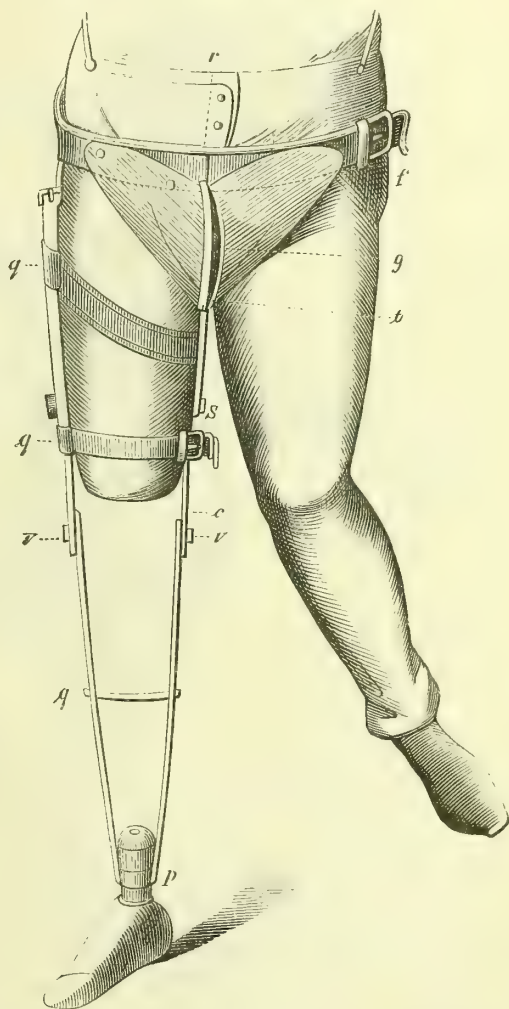


FIG. 163.—Hermann's Artificial Limb.



part of the foot in which the toes are kept firmly pressed down by a spring, which yields to some extent when the weight of the body tells on the anterior part of the foot.

Where the knee-joint is moveable it is in all cases a simple hinge-joint, though constructed in different ways. Formerly the hinge was in the line of the centre of gravity of the body; but in that case, as soon as the knee was a little bent, all support was lost, and walking with these instruments was very precarious. As the artificial limbs are now made the hinge is placed behind the centre of gravity of the body, and much greater stability is thus obtained. When the stump is lifted for a forward step the weight of the leg bends the knee. The leg then swings forward like a pendulum,

and the forward movement is generally assisted with springs, so that it is completed at the time when the patient places his foot on the ground.

In the various forms of apparatus in common use at the present time, as soon as the knee is distinctly bent the patient loses all support on that side, so that those movements which require a somewhat bent knee cannot be carried out at all. The late Dr. Hermann is the only mechanician who has attempted to remedy this defect with any success, and his apparatus, though it has not yet come into general use, is most ingenious, and without doubt could be so modified as to take the place of the forms of artificial limbs at present employed. The description of the apparatus would occupy too much space, but the accompanying figures, taken from Schede's book,

FIG. 164.—Hermann's Artificial Limb.



in which there is an extended reference to it, will indicate its essential principles and advantages (see figs. 162-165). (In these drawings only the skeleton of the apparatus is shown; when used it is covered with a case so formed as to resemble the natural limb.) The apparatus consists essentially of a special pelvic girdle, so made as to transmit the weight of the body from the whole surface of the pelvis, instead of from one point alone. To this two outside and one inside splints are attached. The posterior external splint has its joint corresponding to the knee at a lower level than the anterior one, so that when the knee is bent the upper end (*m*, fig. 162) slips forward in the groove *n*. If at any given angle of flexion the

weight of the body is put on the limb, the upper end of the posterior splint is arrested by the friction, and further flexion or extension is impossible till the weight is taken off again.

In the formation of a stump for the application of an artificial lower extremity one of the most important questions is the length of the stump. Of course, in any case those stumps which can bear weight (Syme's, Carden's, &c.) are to be preferred to others, for they give a firmer support, and the halt which is so noticeable, especially with moveable artificial limbs, is very much less. It has been objected by some instrument-makers that the stumps in these cases are too long, and that the joint on the amputated side being at a lower level than on the other there will be

FIG. 165.—Hermann's Artificial Limb.



great deformity. This disadvantage is but slight compared with the advantage of being able to support the weight of the body on the end of the stump. In the other stumps which cannot bear weight a sufficient length of bone must be saved to furnish a good lever for raising the thigh or advancing the leg. In the case of the thigh nine or ten inches is a good length, and in the leg division of the bone three or four inches above the ankle-joint will give the best result. As the only pressure on the stump is, as a rule, in front, it is well to have the scar behind the bone in all cases. Of course, the mobility and painlessness of the scar, and the other characteristics of a good stump, must be carefully attended to.

W. WATSON CHEYNE.

ON EXCISION OF BONES AND JOINTS.

EXCISIONS IN GENERAL.

THE operations which are to be described in the sequel are all of modern introduction into practice; for although scattered passages are found in the writings of the medical authors of antiquity which have been held to prove that they were acquainted with the possibility of dissecting out diseased or injured bones, it must be allowed that such passages are in many respects dubious; and it is at any rate certain that operations of this kind were very rare in olden times, that no rules were laid down for them in ancient surgery, and that they had altogether passed out of notice before the revival of surgery as an art founded on rational principles.¹ When this had once happened, an attempt to preserve a limb by removing only the diseased portions of bone was so reasonable, that it was sure to be made; nor will it now be denied by any one that a large amount of success has attended that attempt.²

I propose here, as well as my limits will permit, to treat, *first*, of the general indications for excision of entire bones or of their articular ends, as opposed to treatment without any operation, or to incision and drainage of the joint, or to orthopædic measures, or to amputation; and, *secondly*, to describe the operations in use for removing the joints and certain entire bones, which are accessible to such treatment.

The success of excisions, as of all other surgical operations, has of late years become much greater than it formerly was, and some surgeons (see Ollier, 'Trans. Internat. Med. Cong.' 1881, Surgery) speak of the introduction of the antiseptic method as having revolutionised the surgical indications for excision, and rendered justifiable such proceedings as excision for vicious ankylosis, which, according to them, were previously unjustifiable. I cannot see things quite in this light; and any such estimate of antiseptic treatment appears to me to depend on the fact that these operators have been accustomed to practise in hospitals where the arrangements for surgical treatment were so defective that only indispensable operations ought to have been performed. Such were formerly the hospitals of Paris,³ such also seem recently to have been many German hospitals;⁴ and in such institutions there is no doubt

¹ I have not space here to trace the history of excisions from the introduction of the operation by Park and the Moreaus; but would refer the reader for this, and many other points connected with the history and statistics of excision, to a very valuable essay on *The Excision of Joints*, by Richard M. Hodges, M.D., Boston, U.S., 1861.

² Of the success which may attend the practice of excision in properly selected cases, there are some striking instances in the *Med.-Chir. Trans.* Thus, in vol. lii. of that series, Dr. Humphry reports that he excised the knee in forty-five patients, of whom one was under treatment, thirty-three recovered, two died, and nine underwent amputation, of whom five recovered and four died. Many of these cases were in adults, one being as old as 47. In the same volume Mr. H. Lee contributes a table of twenty-two cases of excisions of the large joints with only two deaths, both after excision of the knee. Here, however, there was only one patient who recovered from excision of the hip or knee beyond the period of childhood. In vol. liii. Mr. Gant gives an account of twenty cases of various excisions without a death; nine of these were excisions of the knee—the eldest 33 years of age—three underwent amputation; six were excisions of the hip—the eldest 26 years of age—the other five were cases of excision of the elbow—the eldest 50 years of age. Re-excision was performed in one of the knee and one of the elbow. Still lower rates of mortality seem now to prevail. Thus, out of eighty-nine consecutive cases of excision of the knee at Guy's Hospital (most of them no doubt in children) the deaths were only six, and thirty-seven consecutive cases took place without a death. Holmes, 'Address in Surgery,' *Brit. Med. Journ.*, Aug. 14, 1880.

³ See the account of the Parisian hospitals by Dr. Bristowe and myself in the *Report of the Med. Off. of the Privy Council*, 1863.

⁴ See the description of the hospitals under the care of Profs. Volkmann and Nussbaum in MacCormac, *Antiseptic Surgery*, pp. 26, 56.

that the introduction of Professor Lister's treatment will entirely revolutionise the practice of surgery. But it is difficult to see why a more rational system of hospital management should not be equally successful in those countries as in this; and such an improvement would have the great recommendation that not only the subjects of surgical operations, but all the other patients of the hospital (who are the great majority), would reap its benefits. Certain it is that in our hospitals no such revolution has been seen. It is the opinion of some surgeons (among whom I may reckon myself) that when the antiseptic method can be fully carried out, excisions do better than when it cannot. But under more simple methods of treatment our cases used to do very well. I give on pp. 747-8 a résumé of a series of cases of excision of the elbow, extending back many years, and with few cases treated antiseptically, yet without a single death. And, I may add, that in numerous cases in which I have excised the knee for vicious ankylosis, both with and without antiseptics, I cannot recall a death. So that I am not disposed to admit that the introduction of this treatment has, in any essential particular, modified the indications for excision.

In considering the question between excision and what may be termed the expectant treatment, it may be laid down as a general rule that a large or important joint ought not to be excised while any reasonable prospect exists of a cure without operation; but when bones which are of no great size, and removable by a moderate operation, are extensively diseased, the surgeon may very reasonably propose to cut short the disease by excising the entire bone, while yet he may allow that recovery is not hopeless should the patient's circumstances allow of his obtaining prolonged and judicious treatment; for the result of prolonged treatment is always doubtful, and the most fortunate termination which could be obtained by many months or perhaps years of care will leave the patient's condition little better than the operation from which he will, in all probability, recover in a few weeks. I have had very frequent opportunities of noting the success of operations for the removal of bones of the tarsus and metatarsus, and the superiority of such treatment to that of waiting for a cure—especially in children, whose restlessness renders confinement less likely to be borne. In the hand and wrist, however, such operations are far less applicable.

The question between excision and expectant treatment must further be separated, as applied to cases of disease of joints without any affection of bones, and those of caries of the joint ends. If there is no evidence of disease of the bony surfaces, but the joint is distended with purulent secretion, free incision and drainage should no doubt be practised before any question of excision occurs. On the failure of this plan (or, perhaps, in the elbow, on the occurrence of ankylosis) excision will be indicated, unless the constitutional condition of the patient renders amputation necessary. In cases of chronic thickening of the synovial membrane much may often be done (as pointed out in the essay on DISEASES OF THE JOINTS, vol. ii. p. 384) by counter-irritation, by incision and scraping, and, possibly, by hypodermic injection of carbolic acid or iodoform into the diseased membrane, to arrest the disease and save the limb; but there will remain cases where the disease makes slow but steady progress, and where, sooner or later, the operation of excision will probably be required.

In such cases, it is not so much the present state of the limb, as the conviction entertained by the surgeon that the disease will go on from bad to worse if not eradicated, that induces him to operate, and hence there is always some doubt whether the operation was really necessary. It is mainly in the knee that the question arises, and it will be again discussed in the section of this essay which refers to that excision.

Chronic rheumatic arthritis (or arthritis deformans) is another condition in which excision may be successfully practised, but in which it is not often attempted. It is only rarely that this affection is limited to a single joint, yet is in so advanced a state in that joint as to justify so grave a measure; and as the disease, though painful and disabling, yet is not dangerous either to life or limb, the operation cannot be pressed upon the patient as being necessary. My own experience of excisions for this cause is at present limited to one of the elbow, which was very successful, and one of the knee in an elderly woman, where amputation became necessary on account of secondary hæmorrhage.

The most frequent cause, however, of excision of joints is on account of disease of the articular surfaces of the bones; such disease being usually a diffused carious condition, though occasionally a limited portion may be necrosed and loose, with, of course, some ulceration around it. In the latter case, the operation may often be avoided by extracting the sequestrum, and that is the course which should be pursued in all joints except, perhaps, the elbow, where ankylosis is undesirable. In diffused caries, the choice lies between the purely expectant treatment, with a view to ultimate ankylosis, the removal of the carious bone by scraping or by some caustic, and the operations of excision or amputation. The first is a very tedious process, yet in the case of the hip is often preferable to any other, while in most other joints the necessities of life, the uncertainty of the result, and the patient's intolerance of prolonged confinement and suffering, compel some active interference. I cannot say that, for my own part, I have seen encouraging results in the large joints from the use of sulphuric acid and such measures; nor is the removal of carious bone by the scoop often feasible or safe; so that in confirmed caries of the joint ends, either excision or amputation is generally resorted to. In the case of extensive caries of one of the short bones, such as the tarsal or metatarsal bones, complete resection is often the best course; and even when a sequestrum exists, and the case appears to be one of pure necrosis, this is often really only a result of caries, so that the removal of the sequestrum (though no doubt it should first be tried) does not arrest the disease. More or less free gouging is generally (and most properly) tried before resorting to the total removal of the diseased bone; but the latter measure is indicated on the failure of such gouging operations, and often checks the spread of the disease into neighbouring bones, and thus obviates the necessity of ultimate amputation. The periosteum can often be peeled off the affected bone with perfect facility and left behind. Whenever it is possible, and when the resulting mutilation is not too great, it is undoubtedly safer to resect the whole of a diseased bone than to perform any partial operation.

The indications for a choice between excision and amputation in any given case may be studied under the following heads: 1. The situation and functions of the bone or joint to be excised; 2. The state of the patient as to general health, constitutional affection, and age; 3. The nature and extent of the disease; 4. Various extraneous circumstances.

1. As to the situation and functions of the bone or joint affected. In the upper extremity, almost any excision which affords a prospect of preserving to the patient the motion of the elbow, of the hand, of the fingers, or even of the thumb only, is to be preferred to amputation, even although the patient may not recover useful motion in the joint operated on. There is, however, a limit to the application of this rule, since a limb which swings useless, like a flail, may prove more of an annoyance than an advantage. In the hip the question of amputation for disease does not occur under ordinary circumstances, in any case where excision is possible;¹ and in gunshot injuries, which are almost the only cases in which the operations are pitted against each other, the nearly uniform fatality of primary amputation at the hip, in modern military surgery, gives the surgeon a decided leaning to excision. In the knee the question is more difficult, and the advantages of the stiff limb, left after even the most successful excision, over the artificial substitute are not so great as to balance, in the minds of some surgeons, the increased danger to life which the operation entails, combined with the risk of failure and the possibility that consecutive amputation will become necessary. But excision of the knee is now generally adopted in patients otherwise healthy, when the disease is only of limited extent, so as to be curable by the removal of thin slices of the affected bones. In injuries of the knee, excision has not as yet been much practised, nor has the experience obtained of it been very satisfactory; the injuries to the knee that demand operation in civil practice are generally too extensive for excision, and other reasons usually preclude it in military

¹ In rare cases amputation at the hip-joint is, I think, justifiable, when the disease extends too far for excision, or the knee is simultaneously affected. The point will be discussed further on.

surgery; but in limited injuries it will occasionally be attempted in both civil and military practice. Below the knee, the excision of large portions of the bones of the leg seems much practised in Germany; but chiefly in necrosis, of which we shall have to speak presently. The excision of the ankle has yielded satisfactory results in the hands of Mr. Hancock¹ and other operators, amongst whom I may reckon myself; but amputation at the ankle-joint is so much less severe an operation, and so much more sure of success, that even now few surgeons care to attempt excision. In cases of injury to the ankle, the comminuted portions of bone may occasionally be removed and a useful foot preserved; but no rules can be laid down on this point. In the tarsus, the removal of the os calcis when much diseased or extensively injured is a very successful operation, and one which should always be preferred to amputation. The astragalus, when dislocated, has been excised without much impairment to the usefulness of the foot, and I have on several occasions removed the entire bone in chronic disease with a very good result. The bones of the front of the tarsus are far less favourably situated for excision, since they are all enveloped in the folds of a common synovial membrane, and therefore are prone to participate in each other's diseases; but still, in the cases, which are so common, of caries attacking the cuneiform or cuboid bones, an attempt ought always to be made to save the foot by removing the bones affected whenever the disease has not spread too far. When one or two metatarsal bones are extensively diseased, they should be dissected out, the toes being removed at the same time, if the operator thinks fit.

2. With respect to the state of the patient, it may be said, in general terms, that excision of large joints is only to be recommended for patients in good health, not worn out by previous disease or confinement, nor deeply affected with constitutional taint (rickets, struma,² rheumatism, or syphilis); nor should such an operation be practised in the joints of the lower extremity on patients past the middle period of life. In the very early period of life, also, many risks may be run with a view of avoiding excision and preserving the limb entirely; and, after the failure of such attempts, the case has usually passed beyond the reach of excision, when amputation becomes necessary. So that excisions are almost exclusively practised in childhood, youth, and early manhood.

3. As to the disease—excision is never to be recommended for the removal of malignant diseases of the joint-ends or other parts of the bone. It is true that such operations have been practised by very good surgeons; but they must be regarded as experimental proceedings, justifiable in the early period of the operation, but contra-indicated by more extensive experience. Nor should excision be practised on account of acute abscess of the knee-joint, and only with much caution in acute diseases of any joint. It is much better to endeavour by free incisions and appropriate treatment to support the patient through this stage, with a view of removing the joint (if the extent of the disease renders it practicable) at a later period; but should the patient's health be giving way under the irritation of acute abscess, amputation is indicated in the knee and ankle, and the prospects of excision in other joints are very much less favourable than in chronic cases. The most appropriate cases for the excision of joints are those of chronic disease of all the tissues ('white swelling'), in which the bones are probably not affected to any great depth—a disease which may be due to a strumous taint, but in which the constitutional affection has subsided or is no longer active. In chronic abscess of bone occurring near the articular surface and making its way into the joint, excision may be practised with every chance of success, provided the abscess is not too far from the joint-surface. Necrosis of the articular surface only is another favourable condition for excision; but in many cases the mere removal of the sequestrum will suffice. For excision of entire bones, necrosis of their shafts is the most favourable condition, since the periosteal sheath may be

¹ Barwell, *On the Joints*, 2nd edit. p. 667.

² I have, however, removed the elbow-joint in strumous children with very good results, though there has been extensive strumous disease elsewhere; and excision of the hip is sometimes necessary in children who have strumous disease in other parts of the body; but the prospect of a completely successful result is of course not very encouraging.

relied on to reproduce the bone to a sufficient extent to restore the functions of the member. In such conditions whole bones of the upper and even of the lower extremity have been removed, without any detriment to its ultimate usefulness. In extensive caries, on the other hand, amputation is clearly indicated in the lower extremity; while even in the shoulder, elbow, and wrist, though an attempt to preserve the limb when the carious disease extends considerably beyond the epiphysal ends may not be unjustifiable, it must be allowed to be of very doubtful benefit.

4. The extraneous circumstances which may decide the surgeon to perform amputation, in a case otherwise favourable for excision, refer principally to the lower extremity, and depend on the facilities for after-treatment. Excisions in the lower limb require, in order to have a fair prospect of success, uninterrupted care and unbroken repose, in appropriate position, from the moment of the operation, for many weeks or even months. Hence the great rarity of the performance of excision of the knee in military practice, and the bad success which has attended it. Or the patient's irritable habits and impatience of confinement may occasionally lead to the preference of amputation.

General Observations on the Operations of Excision.

In the resection of any large joint, except the hip and the shoulder, I prefer in ordinary cases to remove the whole articulating surface. Partial excisions, though they appear to succeed well enough in the two great ball-and-socket joints, are repudiated in the case of the large ginglymoid joints by most surgeons of experience;¹ and even in the hip and shoulder many prefer total excision. The application of Esmarch's bandage is peculiarly advantageous in excision by enabling the operator to judge of the exact state of the bones and synovial membrane. It is necessary, in the first place, to divide the soft parts freely, in order to be able to turn the ends of the bones out of the wound, and apply the saw above the articular surfaces, and care ought to be taken to make the sections as clean and smooth as possible. In the upper extremity, where freedom of motion after the operation is sought for, it is desirable to prevent too extensive cicatrization, and especially the adherence of the cicatrix to the bones. Therefore, when the operation is completed, the parts should be carefully readjusted; those portions of the wound in which it is wished to secure speedy union without puckering should be brought together with silver sutures, while free exit for discharge is allowed in other parts of the incision. The difficulties sometimes met with in excisions depend chiefly on the matted condition of the soft parts, on the formation of adhesions between the diseased and semi-dislocated bones, and on the contraction of the tendons. In consequence of all these circumstances, the knife must be kept close to the bones when they are reached, in order to avoid any part which it may be desirable to spare, but which the morbid condition of the tissues prevents the operator from seeing; and the surgeon must be prepared to vary his proceeding slightly with the varying condition of the articulating ends of the bones. The operator should be careful not to confound with caries that roughening of the surface of a bone which is produced by healthy periosteal inflammation, spreading from the diseased joint, and often extending to a considerable distance on all sides of it. Such was the case in the instance here figured (fig. 166), where the section has passed through the roughened portions, but the whole of the carious part has been removed. It is quite unnecessary to remove the parts affected merely with this external inflammation. But the whole of the ulcerated and softened bone-tissue must be carefully eradicated. The thickened synovial membrane, which so often lies around the diseased joint-ends, should always be removed, if possible. Before

¹ Some very good surgeons, however, occasionally resort to partial excision of the elbow. In a discussion reported in the *Med. Examiner*, April 19 and 26, 1877, in which Hueter, Gurlt, Langenbeck, and Schede took part, the prevailing opinion seemed to be in favour of partial excision of this joint, but it seemed to be based on a very much less favourable experience of the results of total excision than those to which we are accustomed.

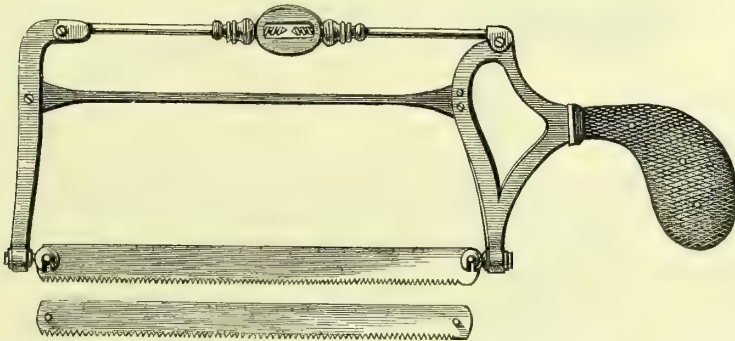
the patient has recovered his consciousness, the limb should, in all cases, be carefully secured upon a splint, in the position it is intended to maintain for the first few days after the operation. This position need not necessarily be the one most favourable for ankylosis, except where bony union is desired. In that case the limb ought never to be moved, if it can be avoided, out of the position in which it is intended to ankylose; and the first dressing, or change of splint, after the operation ought to be delayed as long as due attention to cleanliness allows.

As to the instruments required in excisions, little need be said. These operations are no exception to the general rule, that difficulties are better overcome by the dexterous use of common instruments than by the invention of special and often complicated apparatus. The elaborate instruments described, usually in French surgical works, appear to be really intended to save the surgeon from the necessity of thoroughly exposing the bones, by turning down proper flaps, and thus to enable him to remove the bones piecemeal; and if so, their principle is radically bad. The chain-saw, which seems to be much used in France, is hardly ever employed in England, though it may be useful occasionally in deep-seated parts. Some operators like to steady the bone, and

FIG. 166.—Portions of Bone removed in an Excision of the Elbow. (From a preparation in the Museum of St. George's Hospital.)

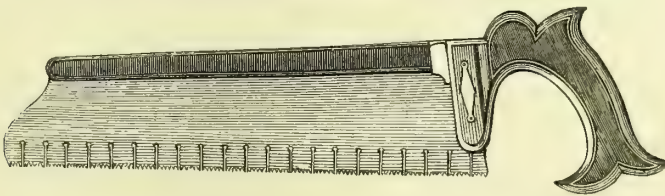


FIG. 167.—Butcher's Saw. (From Maw's Catalogue.)



guard the parts around, by passing under it a large director, mounted on a handle (fig. 169); and such an instrument may be very convenient when the bone cannot be turned out of the wound. The saw called by the name of its inventor, Mr. Butcher, will often be found useful, but for ordinary purposes I prefer to

FIG. 168.—Fergusson's Saw.



use a common amputating saw. Fergusson's saw with movable back is useful when the bone to be sawn through is of great thickness. The large bone-forceps, with a double jaw, called by Sir W. Fergusson 'the lion-forceps,' are almost indispensable for holding firmly the piece of bone which is to be sawed off. These instruments, together with cutting-pliers, a keyhole-saw, gouge, chisel, trephine,

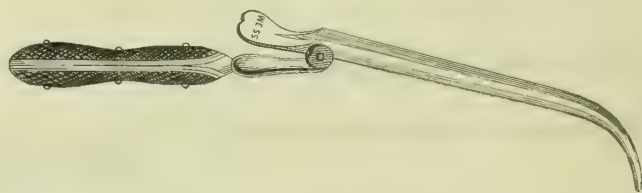
blunt bone-forceps, raspatories, and curved spatulas, are all the special apparatus necessary.

The bones to be removed ought always to be taken away as clean as possible, and if, in removing entire bones or large portions of their shafts, the periosteum can be left behind, it will no doubt be an advantage, as tending to give more firmness to the cicatrix.

Subperiosteal excision.—The general question of subperiosteal resections has lately been brought into much prominence by the labours of M. Ollier, and by the interesting work which he has published on the subject.¹ The operator will find that in many conditions, at any rate, of disease—possibly in most of those in which he is called upon to operate, and in many subjects previously healthy, especially in early life—the periosteum can be stripped off the bone with moderate facility, by using raspatories or chisels with somewhat blunted edges, such as are figured in M. Ollier's work. When this has been done a chain-saw can be insinuated between the detached periosteum and the bone, and the latter removed almost or altogether clean. There are other conditions (those in which active inflammation is still in progress but has not proceeded to suppuration) where the periosteum adheres too closely to the bone to be separated without an amount of tearing and violence fatal to its integrity, and in such conditions the attempt if commenced ought to be abandoned.

There are various advantages and disadvantages connected with the preservation of the periosteum in excision. The bone will in most cases be reproduced, to a certain extent at least, and perhaps entirely.² This reproduction will give firmness to the cicatrix in case of excision of an entire bone, will fill up the gap and add

FIG. 169.—The Excision Director. (From Weiss's Catalogue.)



length to the limb in case of resection of a portion of the entire shaft of a long bone, and will reproduce the articulating portions and the processes for the attachments of muscles around an excised joint. Again, since, in the subperiosteal proceeding, the tendons of the muscles are detached entire from the bone, they will not be so much injured as in the ordinary operation, and will probably obtain better leverage. Finally, as the instrument is kept all the time close upon the bone, there is much less risk of injury to the neighbouring vessels and nerves. On the other hand, the operative proceeding is long and tedious; it is difficult to remove the bone without detaching the periosteum to some extent from the part left behind; if the periosteum is much handled, it is liable to slough, which delays the healing of the wound and endangers the success of the reparative process; and the reproduction of bone is by no means an undoubted benefit—in many cases is certainly undesirable. Subperiosteal resection, therefore, appears to me inapplicable in several of the special excisions, as will be pointed out in the sequel.

EXCISIONS IN PARTICULAR.

Excision of the shoulder, as the term is ordinarily used, is intended to signify merely the removal of the head of the humerus. The operation is practised in preference to amputation at the shoulder-joint in cases of gunshot wound or compound dislocation, when the injury is not too extensive; and is the only operation admissible in chronic disease of the joint.³ But in cases of rapidly growing

¹ *Traité expérimental et clinique de la Régénération des Os.* Paris, 1867.

² See Dr. Doutrelepont's and Dr. Cheever's cases of excision of the elbow, on p. 744.

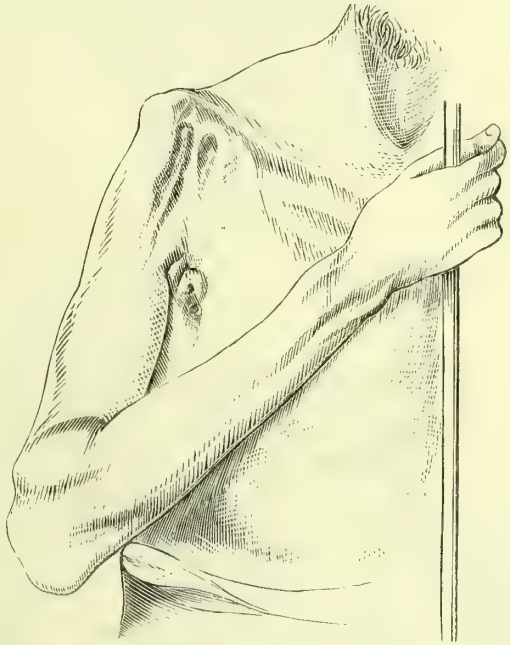
³ I have often thought that in cases of irreducible dislocation attended with much pain the removal of the head of the bone might be justifiable; but have not met with any case in which the operation has been performed.

tumour of the head of the bone, amputation would seem the more prudent course ; and still more so, if the tumour were known to be cancerous. In ankylosis—an affection which is rare in the shoulder—no cutting operation is justifiable.

The head of the bone may be removed, if there is not much thickening over the joint, by a single incision running downwards as far as may be judged necessary from the upper part of the acromion process, over the most prominent part of the head, where it is most plainly felt beneath the skin. This line of incision corresponds pretty nearly to the direction of the long tendon of the biceps muscle. In some cases it is necessary to make a flap out of the deltoid muscle, of a somewhat triangular shape, with its base upwards. The precise position of the incisions which bound this flap is a matter of secondary importance, and is usually determined by that of the sinuses or wounds. The head of the bone, having thus been exposed, is to be rotated (when the shaft is entire) first outwards, in order to stretch the tendon

of the subscapularis, then inwards, to make tense those attached to the greater tuberosity ; these tendons are to be divided, and the capsule thus freely opened, and then the head of the bone is to be thrust out of the wound, and sawn off. If the case is one of injury, and the head of the bone is severed from the shaft, it must be seized with the lion-forceps, and dissected out. The bleeding is usually free, from the posterior circumflex artery or its branches. If the long tendon of the biceps can be distinguished, it should be spared. In both disease and injury, the glenoid cavity often escapes ; but if it should be found affected, it may be thought necessary to remove it. This is best done with a large chisel or with bone-nippers of appropriate shape. The parts should be lightly put together by means of a few sutures, and the patient confined to bed for the first few days, until the consecutive fever has passed over. He may then be allowed to move about, the elbow

FIG. 170.—Drawn from a Patient on whom Excision of the Shoulder-joint had been performed with success many years previously. To show the position of the wound, the shape of the shoulder, and the atrophy of the deltoid and of the upper arm generally.



being carefully supported. The tendency of the muscles which form the flaps of the axilla to displace the bone may be counteracted by a pad in the armpit.

M. Ollier believes that the subperiosteal method is even more applicable in the resection of the head and upper part of the humerus than in any other excision, and has given a very interesting instance of its successful performance in a case where, besides the head of the humerus, more than four inches of the shaft were removed.¹ The resulting shortening did not exceed half an inch. The subperiosteal excision of the shoulder is not so difficult as some of the other similar operations. An incision being made in a somewhat longitudinal direction through the anterior part of the deltoid muscle² down to the bone, the head of the humerus is fairly

¹ Case of Louise Gaillard, *op. cit.* vol. ii. pp. 46 and 514.

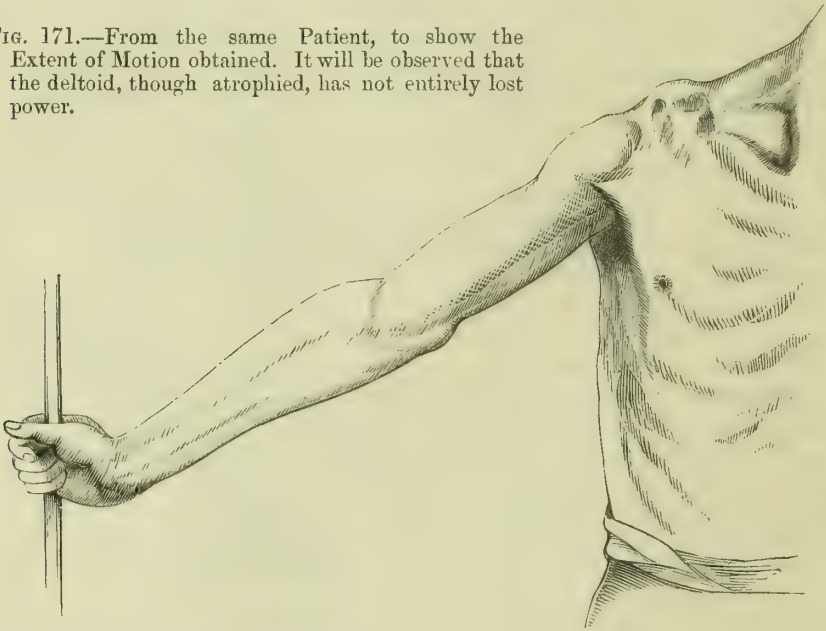
² M. Ollier attaches much importance to the preservation of the major part of the deltoid in connection with its nerve, the circumflex. For this purpose it would be desirable to make the incision between the deltoid and pectoralis major, but for the wound of the cephalic vein which this would involve. It is in order to avoid this injury that M. Ollier sacrifices a small part of the deltoid muscle. Other operators, as Nélaton, recommend a transverse incision.

exposed, and all the tendinous and fibrous structures (including the periosteum, the tendons attached to the greater and lesser tuberosities, and the capsule of the joint), are gradually separated from the bone by the sharp and blunt raspatories. The bone can then be pushed out of the wound, and if it is to be divided lower down the operator proceeds to denude it to any required extent by pushing it upwards out of its periosteal sheath until the saw can be applied. M. Ollier had practised this operation four times, and in all cases with success, removing two and a half inches of the shaft in one instance, and more than four inches in the case above referred to.¹

The amount of bone which may be removed in cases of injury, with a prospect of preserving a useful limb, appears to be considerable. Four or five inches of the bone have been removed with good result.² But no doubt the less that can be taken away the better. In cases of injury, provided all the comminuted portion is removed, fractures or fissures running down from the chief seat of injury may be disregarded. In chronic disease of the joint, the affection is usually limited to the head, except in cases of necrosis; but in necrosis it is more usual to find the shaft only diseased, and the joint exempt.³

The amount of motion obtained after the most successful resection of the head

FIG. 171.—From the same Patient, to show the Extent of Motion obtained. It will be observed that the deltoid, though atrophied, has not entirely lost power.



of the humerus does not seem so great as that which is recovered in some cases of ankylosis after disease. The arm can never, as it seems, be elevated beyond the horizontal line; while in many cases it hangs down, without any power whatever in the deltoid, at a greater or less distance from the scapula. But the movements of flexion, extension, and adduction are usually free; abduction can often be effected to the extent of raising the arm considerably from the side; and there is usually sufficient power in the forearm to carry heavy weights, and perform many of the ordinary domestic tasks. This was the case in the patient from whom figs. 170, 171 were drawn. The arm is therefore a very useful one, irrespective of the vast importance of preserving the hand; and the patient is enabled to follow many of the

¹ *Des Resections des grandes Articulations*. Lyon, 1869, p. 15.

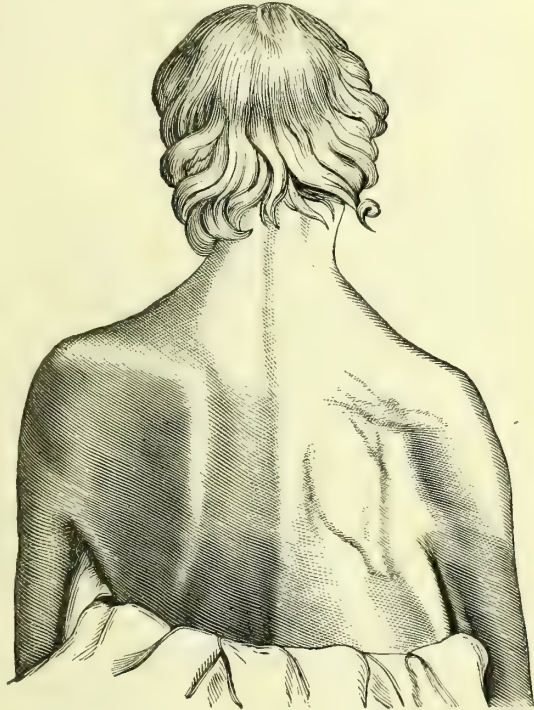
² Hodges, *op. cit.* p. 26; Ollier, *sup. cit.*

³ In the celebrated case of White of Manchester, usually quoted as the first in which excision of the shoulder was performed, a large sequestrum was removed; but it does not appear that that sequestrum involved the joint; in fact, the plate in White's *Cases in Surgery*, fig. i. p. 68, clearly shows that the shaft had separated from the epiphysis, and that the part removed was the necrosed upper portion of the diaphysis.

ordinary trades. It does not appear that any advantage is gained by removing the glenoid cavity; while, as far as can be judged,¹ the operation is rendered more severe and more dangerous to life. Hence, unless disease is clearly present in that part, it should be let alone. I do not find any clear proof in the recorded experience of operators who practise subperiosteal excision that more extensive movement is obtained after that than after the ordinary method. Nor does it seem probable that it should be so. The power to elevate the arm above the horizontal line depends on the rotation of the scapula which carries with it the humerus; the two bones being for the moment consolidated in consequence of their perfect apposition in the joint. When the joint is destroyed, and a ligamentous connection between two irregular bony surfaces has been substituted for it, such a consolidation is impossible, and the rotation of the scapula will no longer elevate the humerus. Unless we could believe that the globular head of the humerus, and the lax, yet air-tight, capsule of the joint were reproduced, we could not expect that the power of elevation would be regained. M. Ollier speaks as if this reproduction were the normal result of subperiosteal resection,² but he refers to no dissection. Now the osseous reproduction which takes place in the elbow after subperiosteal excision has been brought to the test of dissection (see p. 744), and we see how irregular in form the reproduced bones are, and we also see that as a rule the capsule of the joint is not reproduced. We could not admit that the case of the shoulder is otherwise without anatomical proof. Mr. Stokes of Dublin tells me that he has excised the shoulder-joint subperiosteally in two cases and saw no superiority in the results to those of the ordinary operation.

Excision of the scapula and clavicle.—Excision of the scapula has been occasionally practised on account of necrosis, or the bone has been removed, together with a tumour growing from it; the excision, however, in the latter class of cases has usually been only partial, *i.e.* only the portion of the bone implicated in the tumour has been removed. The operation in such cases has usually been protracted and bloody;³ and it may be added that in most of the published cases it was of very doubtful benefit; the tumour being either of a malignant nature, and returning in spite of the operation, which did not seem to prolong life; or else being dependent

FIG. 172.—Drawing from the Photograph of a Patient on whom Excision of the Scapula had been successfully performed by Mr. Pollock. (From 'St. George's Hospital Reports,' vol. iv.)



¹ See the cases quoted by Dr. Hodges, *op. cit.* p. 34. Of the fatal cases there reported (eight in number), there was but a single instance of death where the glenoid cavity had not been interfered with.

² 'In the shoulder' (after subperiosteal excision) 'the anatomical form can be felt to be reproduced. There is a new head, reduced in volume, it is true, but articulating with the glenoid cavity. This head is generally supported by a neck of smaller diameter than the shaft.'—*Trans. of Internat. Med. Congr.* 1881; 'Surgery,' p. 127.

³ See the account by Mr. Liston of such an operation performed for a tumour which he regarded as an ossified aneurism of the subscapular artery, but which was in all probability a malignant tumour of the bone. *Edin. Med. and Surg. Journ.* vol. xvi. pp. 66, 215.

on syphilis, and very probably curable without any operation at all.¹ These considerations—added to the great severity of the operation in cases of rapidly growing tumour, where the large arteries which surround the scapula on all sides are enlarged for the supply of the new growth—ought to make the surgeon very cautious in recommending such operations. The operations on the scapula for necrosis, like all other operations for this affection, have turned out much more satisfactorily; but they bear more resemblance to the usual proceedings for the extraction of sequestra than to formal operations for excision. A case related by the late Mr. Jones, of Jersey, in the 42nd volume of the ‘*Medico-Chirurgical Transactions*,’ will illustrate these observations, and will show what useful motion may be preserved even after the removal of a sequestrum involving almost the whole scapula, inclusive of its articular surface. No special directions are needed for these operations. The position of the sinuses will point out the most convenient directions for the incisions, which should be kept as much as possible upon the limits of the bone, in order to avoid as many of the large vessels as can be spared. The bleeding, however, in these operations for necrosis seems far less than in those performed for the removal of tumours.

The total excision of the scapula for a tumour should be thus performed. The patient being brought under anæsthesia, an assistant should be charged with the compression of the subclavian artery; for which purpose, if the projection of the tumour makes compression difficult, the incisions may be so managed as to enable him to put his finger directly down upon it. This precaution much diminishes the hæmorrhage from the subscapular artery and its branches, which otherwise might be formidable. The surgeon then proceeds to denude the tumour of its outer coverings by turning down appropriate skin flaps, taking great care, however, not to open the capsule of the tumour itself.² When the whole tumour is thus exposed the muscles inserted into the vertebral border of the bone should be rapidly divided, as also those which are attached to the spine of the scapula. The tumour being now movable should be lifted well up, and freed from its other attachments by rapid strokes of the knife, commencing from its *lower* angle. The subscapular artery is divided near the end of the operation, and can be caught hold of by the surgeon or his assistant, and held till the tumour is removed, or can be at once tied. The ligaments of the shoulder are then easily divided and the mass removed.

The acromion process, if not diseased, may be divided with bone-nippers and left behind to preserve the shape of the parts and protect the head of the humerus.

In this way I have seen the scapula removed with a very large and vascular tumour, without any serious bleeding.

The resulting deformity is very slight, especially if the acromion has been left behind to preserve the shape of the shoulder, as was done in the case from which fig. 172 was drawn.

Almost the same general observations will apply to the excision of the clavicle as to that of the scapula—only, as the relations of the clavicle are far more important than those of the scapula, so must even greater caution be exercised in undertaking its removal. It is not only that very large vessels lie in the neighbourhood, which it may be difficult to avoid during the removal of a large tumour passing into the root of the neck, and perhaps lapping over them; but also that the removal of such a tumour from below the deep fascia of the neck involves alarming risk of death from diffuse inflammation. The benefit to be derived from such an operation ought therefore to be most clearly proved before its dangers are encountered.³ In operations for necrosis the proceeding will be far more simple, and is likely to be far more successful. The sequestrum will probably be separated from the subclavian vein and the deeper parts by a deposit of new bone, and the patient will have a fair chance of

¹ *Path. Soc. Trans.* vol. vii. p. 346.

² See Pollock, in *St. George's Hospital Reports*, vol. iv. p. 237.

³ In Mott's case the operation lasted *four hours*, and thirty vessels were tied. Mott says, ‘This operation far surpassed in tediousness, difficulty, and danger, anything which I have ever witnessed or performed.’

permanent recovery. In operating on the clavicle for a tumour, the incisions should be made very free, one over the long axis of the bone, joined by others in appropriate places for turning down such flaps as may appear necessary, and the parts to be operated on should be brought fairly into view before the bone is meddled with. After having freely divided all the superficial attachments of the bone and tumour, the next step is to divide the outer end of the clavicle from the scapula, either by cutting through the joint or by severing the bone with a small saw or nippers. Then the part which is to be removed can be raised, and must be separated with great care from the important parts which lie below it, so as to reach the sternal part, which is last divided, and which serves during the operation as a pivot on which the bone can be moved and supported; or in other cases, it may be found more convenient to divide this part of the bone also at an earlier period of the operation.¹ It appears that very useful motion may be recovered after the removal of a large part, or even the whole, of the shaft of the clavicle.

After amputation at the shoulder-joint, the scapula has been extirpated for recurring disease, and portions of the clavicle have been simultaneously removed. One case is on record in which Mussey, of Cincinnati, removed the whole clavicle and scapula for a tumour recurring after amputation at the shoulder-joint.² The patient survived the operation, and was heard of in perfect health thirty-four years afterwards at the age of seventy-one.³ No directions can be required for the performance of an operation which must vary in its steps according to the condition of the parts left behind after the amputation. Mussey commenced from the inner side, so as to expose and tie the subclavian artery early in the operation; and this would probably be the best course if the state of parts should allow of it. I followed the same course in a similar case under my own care. The patient recovered rapidly from the operation, but died of a recurrence of the disease. Mussey nearly lost his patient from the passage of air into the subclavian vein.

Excision of the elbow for disease may be thus performed. The bones are exposed by a free vertical incision, running parallel and a little external to the ulnar nerve, about four inches in length, having its centre opposite the tip of the olecranon. This suffices for all ordinary cases. If more room is required, the vertical incision may be crossed by one running outwards from its centre. If the head of the radius is found dislocated on the back of the outer condyle (a very common condition in chronic disease of this joint), it may be removed at once with the bone-nippers. The joint should now be freely opened by dissecting round the olecranon, care being taken to keep the edge of the knife close against its inner side, in order to avoid the ulnar nerve, which is usually hidden from view amongst a mass of indurated cellular tissue. The end of the humerus should then be cleaned and turned out of the wound, the lateral ligaments being freely divided; the tip of the olecranon having been previously cut off, if necessary. However slight the disease in the bones may be, the whole end of the humerus just above the condyles ought to be removed. Afterwards the sigmoid cavity of the ulna should be sawn away. It is better, when it can be done without inconvenience, to make the section of the two bones of the forearm on the same level. The wound should be brought together lightly. The limb should then be lightly bandaged on an angular splint, before the patient is restored to consciousness.⁴

Ollier, Langenbeck, and others endeavoured to preserve the periosteum in this excision.⁵ For this purpose, after a free longitudinal incision over the olecranon, the periosteum is also to be freely incised and separated from the olecranon with a blunt or half blunt instrument; then the tendon is to be carefully separated from the olecranon, leaving it still attached to the periosteum and surrounding fascia. In

¹ See Travers, in *Med.-Chir. Trans.* vol. xxi.

² *American Journal of Medical Science*, vol. xxi.

³ *Health: its Friends and its Foes*. Mussey, p. 352.

⁴ Some surgeons merely flex the arm, and apply a roller; but the support of a splint appears to give confidence, and to prevent spasmodic movements: it need not be applied at any particular angle, but merely in such a position as avoids tension on the sutures.

⁵ I would refer the reader on this head to Hueter, in Langenbeck's *Archiv*, vol. viii. pp. 135 *et seq.*; Lücke, *Aphorisms of Military Surgery*, &c. p. 126. Stokes, in *Dublin Quarterly Journal*, May 1865, and especially to Ollier, *Traité expérimental et clinique de la Régénération des Os*. Paris, 1867, vol. ii. pp. 338 *et seq.*

exposing the rest of the bones similar precautions are to be taken to preserve the periosteum and tendons in relation with each other and with the fascia. The advantages claimed for this method are that more perfect reproduction is said to ensue, and with more extended motion. Dr. Hueter asserts that the new joint is even provided with synovia, and he says that the movements of the new joint are sometimes more extensive than those of the natural elbow. Thus in one case the patient could lay the flat of his hand on the shoulder of the side of which excision had been performed, which was, of course, impossible on the sound side. This fact, however, seems to me rather to show the absence than the abundance of reproduced bone, and I shall show that the same freedom of motion exists after the ordinary operation. In M. Ollier's work the reader will find the most ample details on the 'manuel opératoire,' and on the results of this subperiosteal method of excision. His method of operation differs, though only very slightly, from that of Langenbeck. In his work, 'Des Resections des grandes Articulations,' he gives nineteen cases with four deaths, all in adults. Of eleven cases under thirty years of age none died. All the patients whose cases have been followed to their termination had good movement, though in one (M. Dron's case) it seems to have been limited. One of the patients died (of scarlet fever) eight months after operation; but unfortunately an examination of the new joint was not obtained. It must be admitted, therefore, that the only perfectly convincing proof of the reproduction of the articular ends is still wanting in this series of cases. M. Ollier is, however, perfectly certain of the reproduction of a bony mass replacing the olecranon in most of the cases, and of the attachment of the tendon of the triceps to this bone; and also, in some instances, of the reproduction of bony projections from either side of the end of the humerus, giving great lateral stability to the joint. On the whole, therefore, I think we are entitled to conclude that the subperiosteal resection of the elbow, though more laborious than the older methods and requiring more time for its accomplishment, has occasionally yielded excellent results and deserves to be tested by more extensive practice.

My own experience of this method is limited to a single case,¹ in which, although it was a very good case for excision, and no bad symptom followed the operation, the motion ultimately obtained was considerably less than in a perfectly successful operation after the ordinary manner; and this appeared to me to depend on the excessive reproduction of the excised olecranon. Dr. Doutrelepont² has published an account of the dissection of a case in which this operation had been successfully performed at the age of eighteen, about four years before death. In this case the olecranon and coronoid process of the ulna, the head of the radius, and two-thirds of an inch of the humerus, were removed, the section of the latter bone running through the condyles. The drawings attached to Dr. Doutrelepont's paper show that the condyles of the humerus had been entirely reproduced—the internal condyle rather exuberantly, forming a deep groove for the ulnar nerve. The olecranon was also reproduced, and was longer and more curved than natural—a circumstance of much importance. The head of the radius was also reproduced, and was united to the ulna by an orbicular ligament, as in the natural joint. There was a regular joint between the ulna and humerus (an articular surface, surrounded by a capsule, being formed on the summit of the reproduced sigmoid notch), and true hyaline cartilage had also been reproduced. There was no appreciable shortening of the arm, and the muscles were as well developed on that side as on the other. Pronation and supination were almost natural, flexion and extension were perfectly good, but within the limits of 75° to 120° only.

In my own case, also, the limits of flexion and extension were about the same as the above; and here, also, I thought that extension was checked by the excessive reproduction of the olecranon, whereby its point was brought down into the coronoid fossa before the arm had been nearly straightened. M. Ollier has pointed out the danger of this limitation of motion by the curved shape of the new olecranon,³ and proposes to rectify it by treating the arm in a more extended position than that ordinarily used, with adequate precaution, of course, against ankylosis.

Another, and a very complete, report of the reproduction of bone after subperiosteal resection of the elbow is to be found in the 2nd series of the 'Med. and Surg. Reports of the Boston City Hospital,' by Dr. Cheever. The operation was performed at the age of fourteen, seven years before death, and the report is accompanied by photographs both of the portions of bone removed and of the reproduced joint. The portions of bone removed were the

¹ The *Practitioner*, No. viii. Feb. 1869, p. 65.

² Langenbeck's *Archiv*, vol. x. p. 811.

³ *Traité expérimental*, &c. vol. ii. p. 347.

end of the humerus a considerable distance (about three-quarters of an inch) above the olecranon fossa, the ulna below the base of the coronoid process, and the head of the radius. On dissection, the head of the radius was found reproduced, and there was a new orbicular ligament. The radius could rotate through about one-half its normal arc. There was a new coronoid process, into which the brachialis anticus was inserted, and on the side of which was a sigmoid fossa for the radius. The olecranon process was represented by a hook of bone, not continuous with the shaft of the ulna. The triceps was attached partly to this and largely to the fascia of the forearm. A sesamoid bone was found in this tendon. The end of the humerus had been reproduced, growing downwards from the level of section (which was marked by a transverse ridge) three-quarters of an inch on the inner and two inches on the outer side. It was greatly expanded from side to side. The internal condyle and trochlea were represented by a large, partly detached, and irregular mass of bone, to which was attached the common origin of the flexor mass of muscles; while in the place of the external condyle was a long bony hook, which curved round towards the back of the radius, and to which the extensor mass of muscles was attached.

Referring to the general description of the functional utility of the member, the case was certainly a successful one; but there is nothing to show that the result was in any way superior to that often obtained by the old method; and a glance at the photographs of the reproduced joint will show that much of the new bone must have been, to say the least, superfluous, if not an impediment to motion.

Mr. Stokes, of Dublin, was so kind as to inform me, at the date of the last edition of this work, that he had then practised the subperiosteal excision of the elbow five times. The first two operations, in children aged about ten and twelve, did extremely well, the wounds healing rapidly, with obvious reproduction of bone and excellent movement. The third patient died about two months after operation, and there was no opportunity of examining the joint. In the two other cases (adults), the power of flexion and extension was extremely limited—one almost ankylosed. His subsequent experience has led him practically to abandon the subperiosteal method, since he finds that the ordinary operation gives equally good results.

From all that I have seen and read on the subject, therefore, I must say that the advantages of the subperiosteal method in this excision are at present doubtful.

The extent of bone which may be removed in an excision of the elbow is considerable; in fact, within the proper limits, it seems as if the more bone is removed, the better is the result. If only the extreme ends of the bones be sawn off, ankylosis will most likely take place; while if the amount above prescribed (*viz.* the whole condyloid extremity of the humerus and all the sigmoid cavity of the ulna with the head of the radius), or even a little more on both sides, be taken away, free motion may, under favourable circumstances, be expected. An exaggerated idea, however, appears to prevail, of the amount of bone which may be excised with a prospect of preserving a useful limb. This idea has originated from confusing operations undertaken for necrosis with those for injury or chronic disease (caries). In the former, the whole shaft of a bone has often been removed, and a useful limb left. In the latter, especially if the periosteum be removed with the bone, only a limited quantity of bone can be taken away. If the limits above pointed out have been somewhat exceeded, and still at the point of section the interior of the bones is obviously diseased, it is better, if the disease is not in a very advanced condition, to remove all the bone which is quite disintegrated, preserving what is merely softened, and thus give the patient a chance of saving his limb; but if complete disorganisation extends far into the shaft, it is, I think, advisable to amputate, although perhaps in a young and healthy patient the operator might be justified in trying the subperiosteal extirpation of the diseased bone. The position of the line of section in relation to the junction of the epiphysis is a matter of subordinate importance in this joint, since it is so much more necessary to obtain a flexible but firm union, so as to allow of good motion, than to avoid any amount of shortening of the affected arm.

The arm should be left perfectly quiet for a few days, in the position in which it has been placed after the operation, free drainage having been secured. A good deal of irritative fever often supervenes. When it is necessary to change the dressings for the sake of cleanliness, a grooved splint should be applied, which will lodge the arm and forearm, and which is jointed in the centre and movable by a rack and pinion; with this apparatus, the arm may easily be got into such a position as will

afterwards be useful, by gradually changing the angle. Passive motion, however, of a more vigorous kind must not be neglected, the time at which it is commenced varying with the state of the wound and the quantity of the bone which has been removed. If much has been taken away, ankylosis is little to be apprehended; otherwise, at a period which may be roughly stated at about three weeks, daily passive motion ought to be commenced. In the most favourable cases a very perfect false joint succeeds to this treatment; and an amount of motion is regained, which for practical purposes is little inferior to that of the original joint.

Of this a very interesting example is recorded by Mr. Syme, in which he had the opportunity of dissecting the new joint, nine years after the operation, which had been performed on account of injury—the man having in the interval acted as guard on a railway, swinging himself from one carriage to another while the train was in motion, with the injured arm, quite as easily and securely as with the other. The ulna was found united to the humerus by ligament; the end of the radius was polished off, and played on the humerus and on the ulna, a material something like cartilage being interposed. The ends of the bones of the forearm were locked in by two processes projecting downwards from the humerus, and strong lateral, and still stronger anterior and posterior, ligaments also bound them to the latter bone.

FIG. 173.—Reproduction of the Elbow-joint, after Excision, in Mr. Syme's case. (From the 'Lancet,' 1855, vol. i.)



a, the humerus; *b*, the ulna; *c*, the radius; *d*, *e*, projections from the shaft of the humerus, locking in the bones of the forearm in the new joint; *f*, new orbicular ligament around the head of the radius; *g*, a portion of the ligamentous union between the ulna and humerus; *h*, tendon of the biceps; *i*, *k*, new lateral ligaments, attached below to the end of the ulna on one side, and the orbicular ligament on the other.

Union, is, however, seldom so perfect as this, and the bones seem to be united merely by more or less extensible ligament.¹ In these cases, it is said by M. Robert² that flexion is composed of two movements; the forearm being first drawn up to the humerus by the triceps, and then flexed by the action of the biceps.

I append drawings from a case in which I excised both elbow-joints of a child aged five,³ taken four years after the operation. The drawings show the amount of motion obtained in a perfectly successful case by the old method, and they prove that when the preservation of periosteum is quite disregarded the same extent and freedom of motion may be obtained as Dr. Hueter (above quoted) appears to believe to be peculiar to the subperiosteal operation. Mr. Syme's case also shows that considerable reproduction of bone may ensue, by growth from the sections, irrespective of periosteal reproduction. These facts, together with the obvious and proved inconvenience of superabundant bony reproduction in this operation, tend still further to make us hesitate in admitting the advantages of the subperiosteal method.

Osseous ankylosis ought very rarely to occur. If the ulnar nerve be injured, a good deal of wasting of the muscles and loss of motion has been observed to follow, and that even in parts not supplied by the injured nerve; and this fact should make the operator careful to avoid the nerve. On the other hand, cases have occurred to the most experienced operators, in which the nerve was wounded; and one is on record in which it re-united, and no loss of motion or other ill consequence followed.⁴ If the patient recover, but with disease persisting or recurring in the ends of the bones, the question of again excising the diseased portions will occur. If necrosis be present, no doubt can exist of the propriety of removing the dead portions, should they be loose; but if the exposed parts of the bone be fixed, or if the disease be caries rather than necrosis, no operation should be performed while the functions of the member appear to be improving. When this is not the case, it is right to try once

¹ Notes of the dissections of several cases, after successful excision of the elbow, may be found in Wagner, *On Repair after Resection*; translated for the New Sydenham Society by the writer, 1860. There are also now a good many preparations in the various pathological museums.

² *Gazette des Hôp.* Nov. 20, 1858.

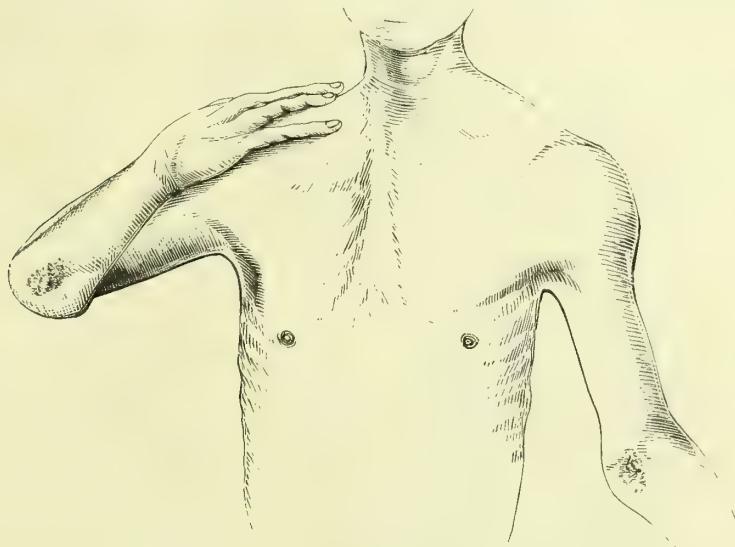
³ *Clin. Soc. Trans.* vol. i. p. 143.

⁴ Syme, *On the Excision of Diseased Joints*, 1831, case viii. pp. 88–94.

more to remove the diseased bone before sacrificing the arm. Even a third such attempt has been made, and, as it is said, with good results.

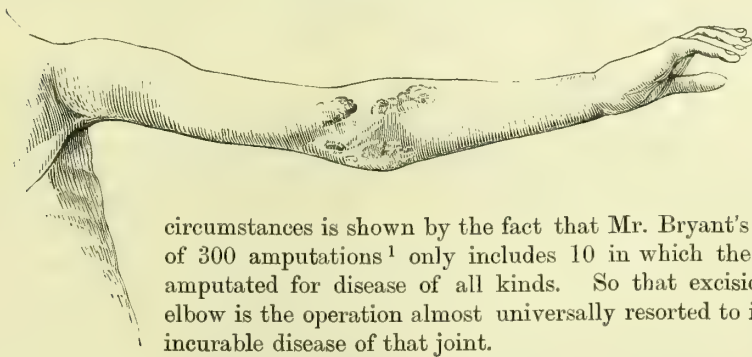
In the essays on INJURIES OF THE UPPER EXTREMITY and on GUNSHOT WOUNDS the reader will find the indications for amputation, excision, or entire preservation of the limb, in cases of injury. In cases of ankylosis of the elbow excision is rarely required, although where true bony ankylosis has occurred in a bad position, excision

FIG. 174.—The Excised Elbow in Extreme Flexion. It will be noticed that this motion is more extensive than in the natural joint, the hand being laid flat on the shoulder.



may be performed if the patient wishes it; but in bony ankylosis in the flexed position, and in all cases of soft ankylosis, this operation is inadmissible. The former ought to be let alone; the latter are under the control of the methods described in the essay on ORTHOPÆDIC SURGERY. In cases of disease of the bones of the elbow excision is the operation which should be adopted, except under special circumstances necessitating amputation, such as unusual extent of implication of the bones, advanced age, great debility, or constitutional affection. But the rarity of such

FIG. 175.—The Excised Elbow in Extreme Extension.



circumstances is shown by the fact that Mr. Bryant's collection of 300 amputations¹ only includes 10 in which the arm was amputated for disease of all kinds. So that excision of the elbow is the operation almost universally resorted to in cases of incurable disease of that joint.

The danger of excision of the elbow as ordinarily performed on account of chronic disease, whether the remote effect of injury in a healthy subject or the so-called 'strumous' disease, is very slight indeed. That this is so may be judged of from the experience of St. George's Hospital, where a series of thirty-nine excisions of the elbow may be found in the summaries of surgical cases contained in the first

¹ *Med.-Chir. Trans.* vol. xlii.

ten volumes of the Hospital Reports. Thirty-one of these were excisions for disease in patients varying from three to thirty-seven years of age (six only being below fifteen), and in all conditions of general health; some, though probably only very few, known to be suffering from grave visceral disease. Not one of these patients died, nor did any suffer amputation, as far as is known.¹ In about six cases it appears that the limb was useless or the wound unhealed. In twenty-one it is distinctly stated that the limb was useful, and in some, whose cases were under observation for a long time, it seemed little inferior to the other. Nothing can show more strikingly the little risk involved in the operation than an unselected and continuous series of cases like this. I may add that only a very few of the cases were treated antiseptically. Primary excision for the direct result of an accident is an operation of much more danger, and, as I believe, much less successful in its ultimate results. Only three cases of primary excision are recorded in the above series. Of these two died, but in one case from other injuries. The other was a very singular and inexplicable case of rapid gangrene, not dependent on any visible lesion of the vessels or soft parts, necessitating amputation, but recurring in the stump and proving rapidly fatal. The patient was a very healthy-looking, muscular railway porter. The third case of primary excision recovered, but with ankylosis. Another case of secondary excision (*i.e.* excision for abscess in the joint, the result of a lacerated wound) was completely successful.

Of three excisions for ankylosis only one was successful; a second was amputated, and the third died of secondary hæmorrhage. This completes the tale, with the addition of a case in which the joint was re-excised five years after an old unsuccessful excision (elsewhere), but again unsuccessfully.

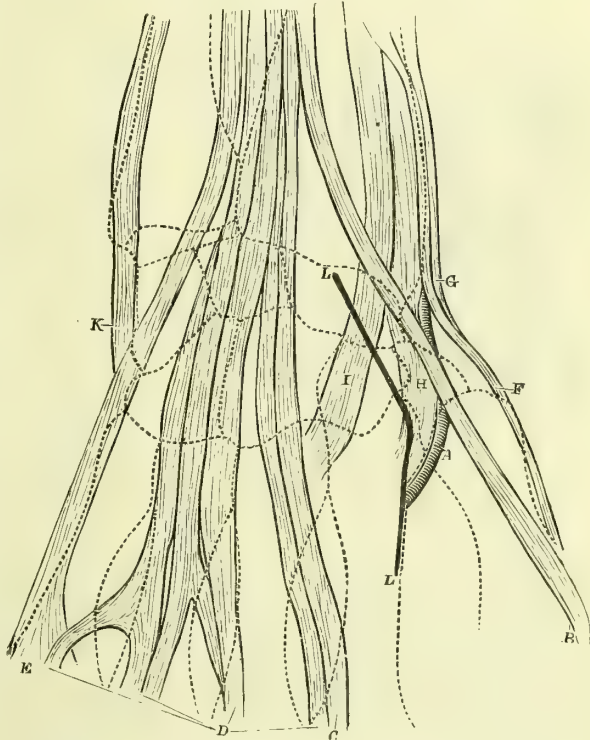
An interesting summary is given in the 'Boston Medical and Surgical Journal' for Jan. 4, 1877, of the practice of Dr. R. M. Hodges, of that city. This comprises twenty-one excisions of all kinds. Fourteen were primary excisions for injury. Five terminated fatally, in two cases from shock or other injuries, in two from septicæmia, and in two from tetanus. Four were excisions for disease, and three for ankylosis. None terminated fatally. The patients who recovered were kept in sight much more than we find it practicable to do in London; and the paper is very valuable, as giving exact details on this point for considerable periods after the operation. All except one retained motion of the elbow, forearm, hand, and fingers; and it is very satisfactory to observe that the use of the limb almost always improved for a very long time after the operation. This would negative an impression which is rather prevalent, that it is a common thing for an arm which has seemed for some time after operation to be strong and useful, then to become weak, flaccid, and even atrophied. I have never met with such a case, nor did any such occur among Dr. Hodges' patients.

Excision of the wrist.—The operation of excision of the wrist has been entirely modified since its first introduction into practice, in consequence of the labours of Professor Lister, published some years since in the 'Lancet.' He has shown that the failures to which the old methods of performing this operation usually led were due in all probability to two chief causes, viz. (1) a portion of the diseased articular structures having been left behind, and (2) the tendons having been injured. In order to avoid the former, it is necessary to remove all the bony and cartilaginous structures which enter into the formation of the wrist-joint itself, and of all the carpal joints, viz. the ends of the radius and ulna (which must be divided at a level above the joint between those bones), all the carpal bones, and all the articulating surfaces of the metacarpal bones. In order to avoid the second cause of failure, the operation must be performed through two very free lateral incisions, the tendons being carefully separated from the bones and raised by gradual strokes of the knife with as little violence as possible. For this purpose an incision is made commencing in front over the second metacarpal bone internal to the tendon of the extensor

¹ I believe, however, that amputation was afterwards performed in one case.

secundi internodii pollicis, and running along the back of the carpus, internal to the same tendon, as high as to the base of the styloid process of the radius. The soft parts, including the extensor secundi internodii and the radial artery, being cautiously detached from the bones external to this incision, and the tendons of the radial extensors of the wrist being also severed from their attachments, the external bones of the carpus will be exposed. When this has been done sufficiently, the next step is to sever the trapezium from the other bones with cutting-pliers, in order to facilitate the removal of the latter, which should be done as freely as is found convenient. The operator now turns to the ulnar side of the incision and cleans the carpal and metacarpal bones as much as can be done easily. The ulnar incision is now made. It should be very free, extending from about two inches above the styloid process down to the middle of the fifth metacarpal bone, and lying near the anterior edge of the ulna. The dorsal line of this incision is then raised along with the tendon of the extensor carpi ulnaris, which should not be isolated from the skin and should be cut as near its insertion as possible. Then the common extensor

FIG. 176.—Diagram of the Excision of the Wrist
(after Lister).



A, the radial artery; B, tendon of the extensor secundi internodii pollicis; C, indicator; D, Ext. comm. digitorum; E, Ext. min. dig.; F, Ext. prim. int. pol.; G, Ext. oss. met. pol.; H, I, Ext. carp. rad. long. and brev.; K, Ext. carp. uln.; LL, line of radial incision.

end of the radius is then cleaned sufficiently to allow of its being protruded and removed. If this can be done without disturbing the tendons from their grooves, it is far better. If the level of the section is below the upper part of the cartilaginous facet for the ulna, the remainder of the cartilage must be cut away with the pliers. The operator next attends to the metacarpal bones, which are pushed out from one or the other incision and cut off with the pliers so as to remove the whole of their cartilage-covered portions. The trapezium bone, which was left in the early stage of the operation, is now carefully dissected out, so as to avoid any injury to the tendon of the flexor carpi radialis or to the radial artery, and the articular surface of the first metacarpal bone is then exposed and removed. Lastly, the cartilaginous portion of the pisiform bone is taken away; but the non-

articular part is left behind unless it is diseased, in which case it should be removed entire. The same remark applies to the hooked process of the unciform.

The operation is one of the most tedious and difficult in surgery, but it appears to me to give very satisfactory results, and therefore should, I think, always be adopted in such cases as are favourable for any operation at all. It is advisable, if not necessary, to put on Esmarch's bandage; so that the view of the parts should not be obscured by blood. It is also very desirable to break down freely any adhesions which the tendons may have formed while the patient is under anæsthesia previous to the operation.

No tendons are necessarily divided in this operation except the extensors of the wrist, for the flexor carpi radialis is inserted lower down than the point at which the metacarpal bone is usually divided.

In order to ensure motion, particularly in the fingers, passive movements should be performed from a very early period after the operation. For this purpose, Mr. Lister places the limb on a splint with the palm of the hand raised by a large wedge of cork, fixed below it; so that the joints of the fingers can be moved without taking the limb off the apparatus. Special arrangements are made for keeping the

FIG. 177.—The parts removed in Excision of the Wrist (after Lister).



splint steady and for preventing displacement of the hand to either side. Careful and methodical passive motion should be used to each several joint—to those of the finger and thumb almost from the day of operation, and to the wrist as soon as the parts have acquired some firmness, each movement, pronation and supination, flexion and extension, abduction and adduction, being separately exercised; and the patient should be encouraged to make attempts at voluntary motion as early as possible. In order to exercise the fingers, the portion of the splint which supports them may be removed, while that on which the wrist is received is still left. Finally, when the rigid splint is left off, some flexible support is still to be worn for a long time.

Partial excisions of the wrist are, I believe, much less promising, although success may be obtained in some cases, especially those of traumatic origin. Thus Mr. West, of Birmingham, has published¹ an interesting account of two cases, in one of which he removed the ends of the bones of the forearm and the first row of carpal bones for a disease of traumatic origin. Exfoliation occurred from the carpal bones which had been left behind, and the patient recovered with a moderately useful hand. In the second case, one of rheumatic disease, an abscess had formed in the lower end of the radius; only the radius was excised. The patient recovered, with the powers of writing and of lifting heavy weights.

The operation of excising the wrist, whether totally or partially, is one which I think is seldom advisable, at least judging from my own experience, for, though anxious to test the value of the operation, I have found only three opportunities of doing so. In two of these cases the patients recovered with useful hands.

It appears to me, however, that in cases where the whole carpus is not affected with disease, it is better to make incisions where they are necessary and remove any bone which is found disintegrated, care being taken to preserve and restore the movements of the fingers as much as possible by passive and active motion. If, however, the disease is so extensive that the removal of the diseased parts is plainly necessary, then the importance of preserving the hand and fingers, even if much mutilated, is so great that excision is the operation which should in all cases be first

¹ *Dublin Quarterly Journal of Med. Sc.* February 1870.

discussed, and amputation should not be performed unless the less radical proceeding is absolutely contra-indicated.

Excision of single bones of the hand.—The excision of some of the bones of the hand may be practised with advantage, especially if the tendons are unaffected and can be secured from injury in the operation. It is of especial importance to preserve the thumb by the timely excision of its metacarpal bone or first phalanx when universally diseased; and the benefit of resecting the diseased portion, and leaving the articulating head, is of course still greater. If the periosteum can be spared, there will be in all probability a more firm union between the severed ends of the old bone, in consequence of the production of osseous granules, or even larger pieces of bone, in the cicatrix.¹ It is of little use to remove the phalanges of the fingers (except those of the terminal row), unless in a few cases where they are necrosed and loose, for the formal excision of these bones would almost invariably leave a useless finger. But occasionally, especially when the extensor tendons can be spared, the metacarpal bones may be made the subjects of operation; and here, as well as in the thumb, it is of much importance, if the extent of the disease allows it, not to open either joint, particularly the phalangeal.

No precise directions are necessary for such operations, which consist merely in exposing the diseased bone on its dorsal aspect, scraping off from it all the soft parts, including the periosteum if possible, dividing the bone with cutting forceps (the extensor tendon being held out of the way), then seizing the divided end with the lion-forceps, cleaning the bone on the lower surface, with much care not to dip the point of the knife into the palm, and finally, when the limit of the disease is reached, nipping off the bone. If the extensor tendon has been unavoidably severed, the finger must be carefully supported on a splint till this has reunited; the ends of the tendon having been united by a catgut suture. In case of disease of the two middle metacarpal bones, it will be better to remove the diseased portions with a small chisel; and this plan is preferred by many surgeons in the other metacarpal bones also, in order to preserve the periosteum.

Excision of the hip is an operation of the value of which the most widely differing estimates have been formed by different surgeons. Nor is this surprising, when it is considered that the disease for which it is usually undertaken is accompanied by exhausting and long-continued suppuration, rendering the prospects of surgical operation unfavourable; while, on the other hand, spontaneous recovery is so common that it is impossible in any case which gets well after operation to affirm with certainty that the natural cure was impossible.

The probability of natural cure in any given case can only be very roughly indicated by figures; still it is interesting to have an answer to the question, asked by Mr. Croft when speaking of excision of the hip: 'Out of 100 cases of hip-disease attended by open abscesses, how many get well without operation?' This question was answered by the experience of the Hospital for Hip-disease, where the records of 260 cases of this nature were preserved. Of these 42·3 per cent. were cured or convalescent on discharge, 24·2 per cent. were incomplete, and 33·5 per cent. died.² If reference be made to the results of the published series of cases of excision, it will be seen that the latter show no numerical superiority over the expectant treatment. The decision, then, in any given case must rest on a careful observation of its symptoms and progress. It must not be forgotten that at the hospital in question alone of all our voluntary hospitals the patient obtains the essential requirement for

¹ Mr. Stokes, of Dublin, remarks: 'When in cases of caries of the smaller bones, the periosteum becomes very much thickened and pulpy, it seems to lose its osteogenetic properties.' I have had many opportunities of verifying this remark, and notably in some of the cases in which there has been the least difficulty in separating the periosteum from the bone. I have now under treatment a strumous girl, suffering also from hip-disease, in whom I excised a carious first metatarsal bone. The periosteum separated from the bone almost spontaneously, leaving a complete membranous sheath; yet no bone has been reproduced in the wound, now many weeks after the operation.

² *Clin. Soc. Trans.* vol. xiv. p. 227.

spontaneous recovery, unlimited time of treatment. The great reason why natural cure is so seldom obtained at our hospitals is because the patient is discharged too early. The period of treatment must be reckoned not in weeks but in years.

Excision is performed on account of gunshot wound or in advanced 'strumous' disease, accompanied by abscess, where the patient seems in danger of dying of hectic, and the ulceration of the bone is judged to be incurable. The hip-joint ought never to be excised on account of deformity from ankylosis, such cases being treated with a large proportion of success by the division of the shaft or neck of the femur (see the section on 'Osteotomy' in the essay on SURGICAL DISEASES OF CHILDHOOD). The operation of excising the hip, as it is commonly spoken of, often means the removal of the head of the femur only; but the acetabulum may also be removed, if it be thought necessary. The operation differs considerably in difficulty, according as the head of the bone is or is not in the acetabulum, and according as the surgeon does or does not require to obtain access to that cavity in order to remove its floor. In most cases of chronic disease the head of the bone has undergone that process of displacement usually, though not very accurately, spoken of as *dislocation*—i.e. the lip of the acetabulum has been ulcerated or absorbed, and the head of the bone (also altered in shape from ulceration) lies partly on the dorsum ilii, partly on the edge of the expanded acetabulum, and is very probably covered by few if any muscular fibres. In fact, in cases of old-standing hip-disease, the muscles have become atrophied from disuse, and the ligaments also have in a great measure disappeared. All that is necessary in the operation is to make an incision of sufficient length over the prominence of the bone, running somewhat behind the trochanter, and, having exposed the head of the bone, to saw it off at such a level as the extent of the disease seems to indicate. When, however, the head of the bone remains in the joint, and the ligaments are entire, as is the case generally in excision for injury, the operation is not quite so simple; and it becomes still more difficult if the neck of the bone is fractured, so that the surgeon cannot get any purchase upon the head to turn it out of the acetabulum. In such cases an incision must be made, running behind and parallel to the posterior border of the trochanter, and long enough to admit of free access to the joint. The length will of course vary according to the size of the buttock, but it may be stated in general terms that the incision should commence near the junction of the trochanter and the shaft, and should curve (with its convexity backwards) round the prominent upper border of that process. By cutting now along the neck of the femur, the situation of the joint may be accurately ascertained, if it has been hidden by swelling from disease or injury; and, this having been done, the parts may be divided from within outwards in any direction which may seem convenient (according to the presence of wounds, &c.), so as to render the external incisions crucial or T-shaped. The flaps are now to be reflected. If the neck of the femur is fractured, the fractured part is to be seized with the lion-forceps, and cleared up to the head and round it, and so removed. Search should then be made for shots, foreign bodies, fragments of bone, &c. If, on the other hand, the neck of the bone is entire, and sufficiently strong to bear the requisite force, it may be more convenient to turn out the head of the bone, and divide the ligaments, as in ordinary exarticulation; otherwise the neck may be cut through with a key-hole saw. This instrument should always be at hand, together with a trephine, elevator, gouge, &c. for removing impacted foreign bodies, or for clearing the acetabulum. In many cases the excision-director (fig. 169) is very useful. I think it better, whenever the disease does not extend very low down, to preserve at any rate a portion of the trochanter.

Thus far we have spoken only of the removal or decapitation of the head of the femur; but since the acetabulum is freely exposed in this operation, it is possible to carry it further, and remove part, or the whole, of the floor of that cavity; and this has been often done with success.

In Mr. Barwell's treatise on 'Diseases of the Joints,' 2nd edit. p. 642, the reader will find an interesting account of a case in which Mr. Hancock removed the whole of the floor of the acetabulum, together with the head of the femur; and where, on the death of the patient,

nineteen months after the operation (his limb having been useful in the meantime, although some disease still existed in the bones), an opportunity of dissecting the parts was presented. Mr. Erichsen removed not only the whole floor of the acetabulum, but also the ramus of the pubes and ischium, with part of the tuberosity of the ischium and a portion of the dorsum ilii; and reports that the patient had a useful limb.¹ I have obtained a very perfect result in a case from which the annexed figs. (178 to 181) were taken, where I removed the whole floor of the acetabulum. It is rather inaccurate in such cases to say that the operator has penetrated into the pelvis. A strong fascia still separates the wound from all contact with the viscera or their cellular connections.

The statistics of this operation are of little real value, nor are they of the same importance as in those excisions where the question lies between the removal of a joint and of a whole limb. The rate of mortality is extremely high; so that out of 111 cases collected by Dr. Hodges,² in which the result was known, 56 recovered 'with more or less useful limbs,' 53 died of the combined effects of the operation and the previous disease, and in the remaining two cases amputation was performed. But it is impossible to deduce any exact conclusion from such facts as these; since without a personal knowledge of each case, no opinion as to the probability of recovery without operation can be formed. Possibly, more reliable conclusions as to the average mortality of operations may be deduced from the experience of individual operators, though here again there are many sources of fallacy. In my own practice, as stated in a work on the 'Surgical Treatment of Children's Diseases,' out of 19 cases (all children) 6 died from the direct effects of the operation (in one case after amputation); 1 died after the operation from the previous effects of the disease; 1 died of independent disease some time after recovery from amputation; 2 recovered from the operation but not from the disease, and died a long while afterwards; 2 were little, if at all, benefited; 1 (twice excised) was doubtful; 3 had useful limbs, but with sinuses; 3 recovered completely. I may add that my practice at that time was (as it still continues to be) to use the operation as a last resource.

Mr. Croft has recorded 45 cases of excision of the hip in his own practice.⁴ Of these 16 died; 11 were under treatment; 18 had recovered, and of these 16 had movable joints and useful limbs. The other 2 are spoken of as 'potentially cured.' Of course a good many of the 11 under treatment would afterwards recover, and it must also be noted that the 16 deaths comprise those which occurred after the operation, but independent of it, as well as those in which death might be connected with the operation. It must be remarked that Mr. Croft is an advocate for early excision.

Dr. Sayre gives much more favourable statistics of this excision in his own practice, but I must repeat that mere statistics are of little use without the indications for operation. Performed early in the disease the operation will have a larger proportion of success, but will be practised in many cases on patients who would have ultimately recovered, and with sounder limbs.

Fig. 178.—Excision of the Hip. (From a case in which the whole floor of the acetabulum, as well as the head of the femur, had been removed several years previously.) To show the position of the wound, the amount of shortening, and the wasting of the limb operated on.



¹ *Science and Art of Surgery*, 5th ed. vol. ii. p. 241.

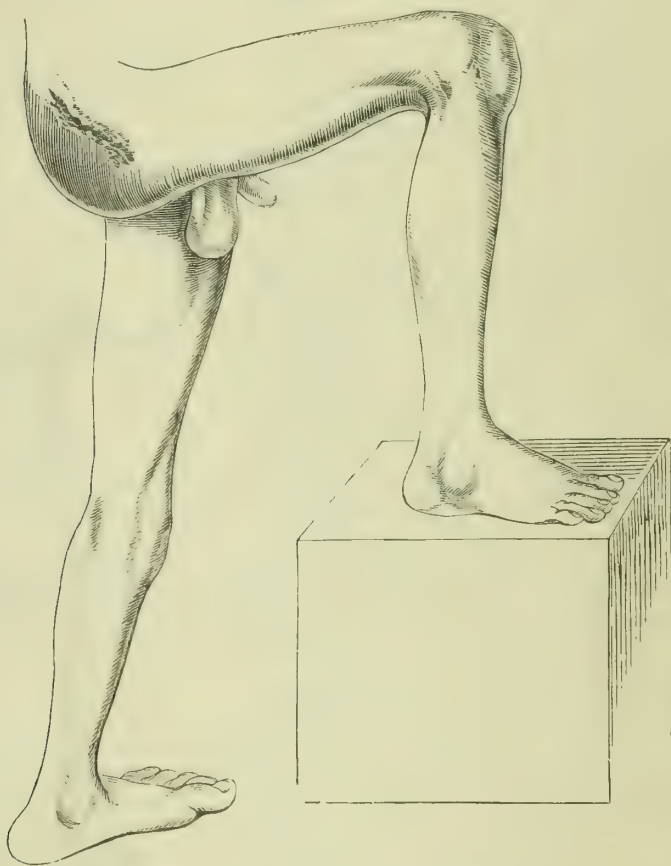
² *Op. cit.* p. 116.

³ All these, I believe, ultimately recovered.

⁴ *Clin. Soc. Trans.* vol. xiii. p. 71.

Excision of the hip for injury is a far more formidable operation than for disease. For this there are several reasons. The shock of all primary operations is great, and their mortality very high; nor are secondary operations after injury much more favourable. In the hip-joint the operation of excision for disease is very fatal in adult life, and it is only adults who, as a rule, are operated on for injury; and then again a compound fracture laying open the hip-joint is in itself a very severe shock, to which that of the operation is to be superadded. Hence we cannot wonder that the records of this operation should present an appalling death-rate. But then excision is only performed in gunshot injuries of the joint; and in these cases primary amputation is almost uniformly fatal, while the expectant treatment can hardly be said to be much more promising.

FIG. 179.—From the same case of successful Excision of the Hip, showing the amount of Flexion obtained.



I must refer the reader on this head to the essay on GUNSHOT WOUNDS, vol. i. p. 559 *et seq.*

In civil life the opportunity of excising the hip for gunshot wound rarely happens; but I remember seeing one case under the care of a former colleague at St. George's Hospital, where I regretted that the operation was not tried. The patient, a young man, in dragging his gun through a hedge had lodged the charge in the hip-joint, the neck of the femur having been cut cleanly across. He died a few days afterwards from the effects of inflammation and abscess in the joint. The pelvis was uninjured.

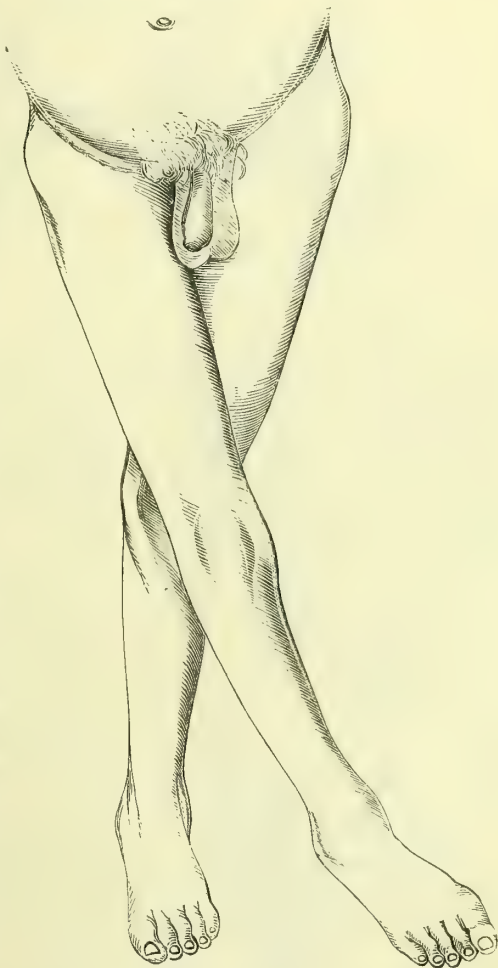
The average duration of treatment in those of Dr. Hodges's cases in which the point was noted (49 in number) was 230 days. The high mortality and the very protracted period of convalescence certainly show that, even in many of those severe cases of hip-disease which alone should be selected for this operation, the patient's

prospects are not materially improved by it, although it must be allowed that the concurrent testimony in its favour of many eminent surgeons, who have had ample opportunities of watching its effects, justifies a resort to it in cases which seem otherwise hopeless. The immediate effects of the operation are not often fatal,¹ and it is, to say the least, extremely probable that where there is great and exhausting pain from pressure of the diseased bones on one another, the operation may save life. The greatest care, however, should be bestowed on the diagnosis of any case in which excision is contemplated. There are few instances of advanced hip-disease in which the external surface of the pelvis is not more or less involved. This fact (which may be judged of partly by the direction of sinuses, partly by the grating sensation elicited by passive motion under anaesthesia) is an unfavourable symptom, but forms no insuperable objection to the proceeding.

Another condition which would appear at first sight strongly to indicate excision is the presence of a sequestrum in the joint, and no doubt when such sequestra are large (as, for example, when the whole upper epiphysis has separated and lies loose and dead in the acetabulum) no prospect exists of their removal in any other way. The character of the crepitus is the only sign, as far as I can see, by which this condition of the joint can be even approximately diagnosed. In the specimens examined by the Clinical Society's Committee some amount of necrosis was found in more than half. But there can be no question that the small 'sequestra' which often exist in a carious acetabulum may exfoliate insensibly, for amongst a large number of cases of recovery from long-continued suppuration at the Hospital for Hip-disease there is hardly a note of any sequestrum having been removed or coming away, yet this condition must have been present in a large proportion of them.

Abscess communicating with the interior of the pelvis near the joint is a still more discouraging symptom, but ought not absolutely to forbid the attempt to excise the joint, since it is possible that, by removing the floor of the acetabulum, a sufficient exit may be provided for the matter.² But even then the removal of the whole of the diseased bone is very improbable, and the operation must be allowed to be very unlikely to succeed. Abscess communicating with

FIG. 180.—From the same case of successful Excision of the Hip, showing the amount of Adduction obtained.



¹ In the Report of the Committee of the Clinical Society above referred to, it is stated that out of 203 cases, 29, or 13·7 per cent., proved fatal directly from the operation.

² Mr. H. Lee has related a very interesting case in which excision of the hip was attempted, but as the disease in the femur was found too extensive, amputation was performed. There was a large pelvic abscess, which was laid open by freely removing the diseased bone forming the floor of the acetabulum. The patient, a boy aged 14, rapidly recovered. *St. George's Hospital Reports*, vol. i. p. 149.

remoter parts of the pelvis, or extensive disease of the femur, or the presence of other strumous affections, ought certainly to forbid the attempt.

Adult age is a serious contra-indication to excision of the hip. A few cases of recoveries after the age of twenty are on record; but as a general rule the operation should be confined to childhood. In one of the successful cases in adult life the operation was performed for chronic osteo-arthritis.

The purport of these indications and contra-indications appears to be that excision ought never to be attempted except in childhood or youth, and never unless, with

FIG. 181.—From the same case, showing the amount of Abduction.



disease still progressing, the joint-surfaces are hopelessly displaced (a very rare occurrence), or the surgeon, on a careful review of all the symptoms, has strong reasons for concluding that natural recovery is impossible. When the operation is once decided upon, it should not be delayed till the patient's health has given way, but should be performed at once.

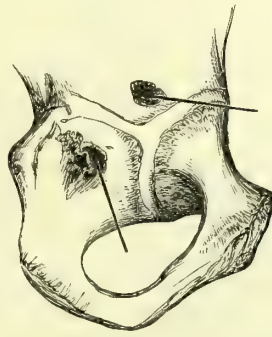
The following is a summary of the Report of the Committee of the Clinical Society, extracted from the 'British Medical Journal,' May 28, 1881:—'The conclusions arrived at by the Committee as to the indications for resorting to the operation of excision are: that it should be adopted in cases—I. Of (1) necrosis of the head of the entire femur, and its conversion into a loose sequestrum; (2) the presence of firm sequestra either in the head or neck of the femur, or in the acetabulum; (3)

extensive caries either of the femur or the pelvis, leading to prolonged suppuration and the formation of sinuses; (4) intrapelvic abscess following disease of the acetabulum; (5) extensive and old-standing synovial disease and ulceration of the articular cartilages, with persistent suppuration; (6) displacement of the head of the femur on the dorsum ilii, with chronic sinuses and deformity. It is pointed out that one

FIG. 182.—The Hip-joint after successful excision, showing the Ligamentous Cord by which the stump of the femur is united to the pelvis.

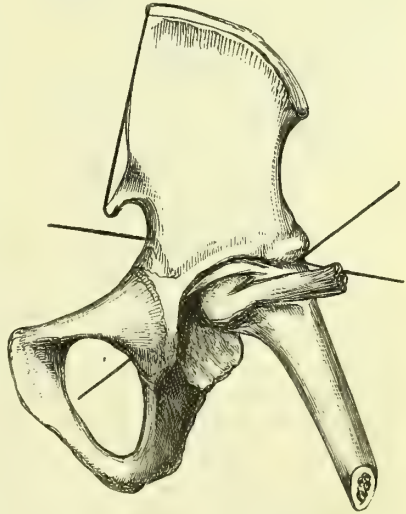


FIG. 183.—From the same case, showing the Inner Openings of two old Sinuses leading through the Acetabulum; their other ends are marked by the bristles in fig. 182.



of these conditions is probably present when suppuration occurs early in the course of hip-joint disease, and is accompanied by severe local and constitutional symptoms. In such cases, loose sequestra may sometimes be found and removed without sacrificing the articulation. II. Excision should also be performed in cases of suppuration when enlargement of the liver, or albuminuria, indicating the presence of degeneration of the viscera, is detected. III. When suppuration continues free, fresh sinuses are formed, or extensive burrowing is in progress, and the patient is losing ground in spite of careful treatment by rest and free drainage. IV. In disease of the pelvis, to provide an efficient drainage for suppuration, which may be sometimes detected near the floor of the acetabulum by the finger passed into the bowel; though pelvic disease renders the prospect of recovery, under whatever treatment is adopted, more than usually doubtful. The Committee consider that complete rest and extension, and the withdrawal of matter, should always be first patiently tried, and operative interference only resorted to when these other means have failed to secure the favourable progress of the case.'

FIG. 184.—Another view of the same preparation, showing the end of the Femur drawn up into the (enlarged) Acetabulum by the Tendon of the Psoas.



The recovery after excision of the hip-joint is very complete, as far as the movements of the limb are concerned, though the shortening is generally, I think, greater than after the spontaneous cure, and the limb is less firm, and, on the average, less useful.¹ The preceding figures (178 to 181) were taken from a lad in whom I excised the hip many years ago, having removed the floor of the acetabulum so freely that

¹ See the *Clinical Society's Report*; also a lecture by me in *Med. Times and Gaz.* Nov. 3, 1877.

three fingers could be passed through it. Every movement of the limb is perfectly free, and almost as extensive as in the natural condition. I saw him last about eleven years after the operation (see 'Med. Times and Gaz.' Nov. 3, 1877, p. 483).

Bony ankylosis very rarely takes place. I have never seen it. The annexed illustrations (figs. 182 to 184), taken from a case where I had excised the hip successfully in a patient who died of another disease, show the usual condition of parts. They correspond closely with the state of things in an interesting preparation in the Museum of the Royal College of Surgeons, taken from the patient in whom the operation was first performed by Mr. White.

Excision of the knee, has been practised more frequently than that of any other joint, except the elbow; but the opinions of surgeons are by no means so unanimous on the former subject as they are on the latter; for whereas no one denies that amputation of the arm should only be restored to in exceptional cases of disease and injury of the elbow, many hospital surgeons, in this city at any rate, think that amputation is advisable in the majority of the affections of the knee requiring operation. There are many reasons why excision should be less successful in the knee than in the elbow. Firm bony ankylosis is required in the lower extremity; the treatment involves many weeks of strict confinement to one position; the surfaces of bone sawn through are very large; the cavity of the wound is badly situated for union; the epiphysal lines are near, and if trephined upon in young subjects, the growth of the limb will, in all probability, be checked; the operation is more severe than excision of the elbow; and, finally, the advantage of preserving the foot, although considerable, is far less than that of retaining the hand. It is not likely, therefore, that this operation will ever come into such favour as that on the elbow; still, though it has been vehemently decried, and though its general adoption has possibly been equally retarded by its having been vehemently over-praised, it will always hold a place among the resources of operative surgery for the treatment of appropriate cases.

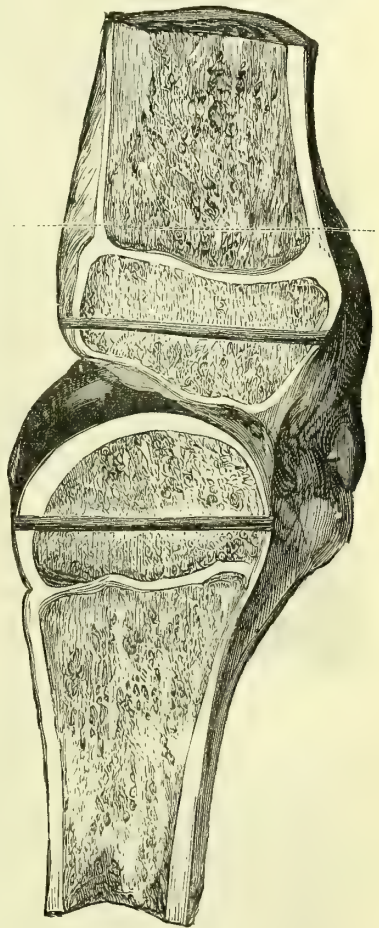
The acceptance which this operation has met with is not due to its lower rate of mortality. No one, I think, now denies that in similar cases the operation of amputation gives a lower rate of mortality than excision. The higher death-rate, however, only imperfectly represents the ill-success of the operation; for to those who have died we must add those whose limbs have been amputated, or have remained useless. In spite of this, however, it is the universal conviction of hospital surgeons that the operation is indispensable in appropriate cases. This conclusion must rest upon other considerations than those of the mere mortality after amputation and excision. It is not very probable that excision of the knee will ever be less fatal than amputation. There is no conceivable reason why it should be so. It is sometimes said that the hæmorrhage is less; but I am far from convinced of this. The blood *shed* in an amputation is always greater than in excision; the blood *lost* is frequently less, for in a well-managed amputation the blood which gushes out is only that which was circulating in the amputated part, and little else is really lost to the system. In excision the operation is often a bloody one (though sometimes not so), and secondary hæmorrhage is by no means rare. Then it is said that the wound is smaller than in amputation; but though the *surface* of the wound is smaller, its cavity (which is at least as important) is larger. The immediate shock, as far as I have seen, is quite as great as in amputation.¹ The surfaces of bone exposed are very large, and the union of this great compound fracture, and the filling up of the large cavity left by the operation, call for considerable reparative power, and entail dangers from which amputation is exempt. But what has really brought excision of the knee into practice, and has compensated for the failures induced by its indiscriminate adoption in all kinds of cases, is its striking success in cases which are fitted for it; and it is, therefore, to the discovery of rules whereby such cases can be diagnosed, that the efforts of those who wish to promote this operation should be directed. The space which an adequate discussion of this

¹ I am informed by Mr. Henry Smith that in more than one fatal case at King's College Hospital death has been attributed to the shock of the operation.

matter would require not being here at my command, I must be excused for expressing summarily what I believe to be the correct indications for the performance of excision of the knee, as far as our present experience will enable us to lay them down.

Excision of the knee should rarely be performed in elderly persons.¹ They have not usually the requisite reparative power; and the advantage over amputation is not sufficient, even in the most favourable case, to balance the increased risk. There are many reasons also against performing the operation in very young children;² such as the probability of recovery without operation, if the suppurating joint be kept in a good position and freely opened; the risk of checking the growth of the limb by excision; the great probability that the joint-disease is but a symptom of constitutional mischief, in which case excision would do no good. No excision of the knee ought to be undertaken in a patient in whom there is any good reason to suspect, far less any evidence of the existence of, phthisis or any other constitutional affection. Had this simple dictate of common sense been more strictly adhered to, many of the deaths which now give so gloomy a complexion to the older statistics of excision of the knee would have been avoided. Excision for disease should be exclusively confined to cases in which the disease is in a chronic condition. In acute abscess the operation is inadmissible. In all cases where sinuses exist, leading for any considerable distance, and generally whenever the disease is of very long duration, excision should only be undertaken as an exploratory measure, and everything should be in readiness for amputation, if the softened condition of the bones should render the latter operation necessary; as will very probably be the case, even if no part should be found absolutely carious or necrosed. In deformity the result of old disease, if the disease have entirely subsided, orthopædic measures will most probably succeed; but if the case appears beyond their reach, no grave operation ought to be undertaken, except at the express instance of the patient; or if a child, of his parents. The operation itself has

FIG. 185.—A section made through the Femur and Tibia in a Child aged five years, to show the position of the epiphysial lines and the point at which the section ought to be made in excision. If the section be made above the trochlear surface of the femur, at the level of the dotted line, the whole epiphysis will be removed. In the tibia, the whole articular surface may be removed without risk.



¹ Speaking generally, and with due allowance for exceptional cases, I mean in persons above the age of forty-five; still, successful cases at a later age have been recorded. In an interesting paper in the *Med.-Chir. Trans.* vol. lvi., Mr. Gant, while relating a case in which he excised the knee with complete success at the age of fifty-three, on account of chronic rheumatic arthritis, says that twelve cases are on record in which this joint had been excised between the age of forty-one and fifty-three. Of these cases seven were successful, and one recovered after amputation. Prof. Humphry is said to have excised the knee of a man over sixty for chronic rheumatic arthritis with success; and I have recently operated with success on a woman over fifty-five for a very chronic affection of the joint. It is only, however, as I believe, in these very chronic cases that the operation should be recommended at advanced ages.

² I do not mean to proscribe the operation in early childhood; in fact I have often operated on very young children; but I regard the best age for this operation to be about puberty.

its own peculiar difficulties and dangers in such cases; but, as a general rule, *opérations de complaisance*, as the French call them, should never be pressed on the patient. Excision for injury, or primary excision, is very rarely required, or justified, in civil practice; and in military practice (as stated above, vol. i. p. 563) it is rarely feasible. The little evidence that we possess at present appears to show that the risk is greater than that of primary amputations. Primary excision ought not to be undertaken except in young subjects, and not in them except in those rare cases where, along with an amount of injury to the joint which renders preservation of the limb without operation hopeless, there is at the same time no such extensive wound, and no such injury to the main vessels, as to necessitate amputation; and even in these rare cases it will always be doubtful whether the injury to the bones is limited to the neighbourhood of the wound, and therefore the operation is always to be regarded as an exploratory proceeding, which may terminate in amputation.

The conclusion from all this appears to be, that the cases most suitable for excision, when the operation is regarded as one of necessity, are those of incurable

FIG. 186.—The same Femur, shown in an anterior view, to mark the level at which the saw ought to be applied.



injury or disease of the knee, in which all the circumstances, both constitutional and local, are most favourable; in which the patient is in the prime of life, and free from visceral disease; and in which there is reason for hoping that the lesion has not spread beyond the epiphysal ends of the bones.

Latterly the operation has come into use extensively as an operation of expediency—*i.e.* as a substitute for the expectant treatment in cases where the patient's circumstances render it unlikely that he can command the rest and attention necessary for his recovery, though the disease may not be in itself incurable. This is perhaps the most successful class of excisions, the patients being usually children in fair general health, and the disease in a chronic condition, but it is of course open to question in every such case whether any operation is necessary.¹

The operation is thus performed. An incision should be made from the back part of one condyle to the back part of the other, passing across the front of the limb below the patella, and slightly convex downwards.² The ligamentum patellæ is to be divided in the first incision; then the soft parts are to be thrown back from the patella and the end of the femur, and the patella is to be removed.³ The joint is now to be freely opened by cutting at the sides of the condyles, so as to sever completely both lateral ligaments;

and then the knife is to be carried round the posterior surface of the end of the

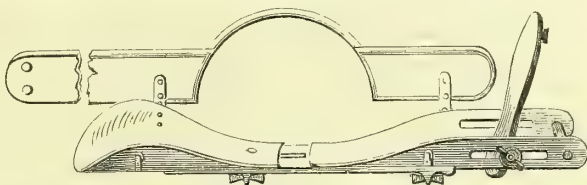
¹ See the Address in Surgery read before the British Medical Association at Cambridge, *Brit. Med. Journ.* Aug. 14, 1880. During the five years ending 1878, eighty-nine excisions of the knee were performed at Guy's Hospital (chiefly in the practice of one surgeon) with only six deaths. No death at all occurred during the last two years, out of thirty-seven excisions.

² Some surgeons prefer to make a long elliptical flap from the front of the limb, including the patella. I myself do not ordinarily use this method, as it makes a larger wound, and renders it somewhat more difficult to deal with the patella. It may, however, be necessary when there is much swelling.

³ It is my invariable rule to remove the patella, and this is, I believe, the usual practice. I can see no use in the bone if left, and much risk of recurrence of disease. (See also Swain *On Excision of the Knee-joint*, p. 73.) Mr. Treves, of Margate (*Brit. Med. Journ.* Feb. 3, 1877), describes a method of removing the bones through two lateral incisions in which the attachment of the quadriceps extensor is left intact, and the patella is either left behind or sawn vertically, but I have no experience of it.

femur, care being taken in doing this to thrust the femur out of the wound as much as possible, by an assistant forcibly flexing the limb, and to keep the edge of the knife directed towards the bone, and guided by the finger, so as to avoid the popliteal artery, which here is separated from the bone only by some fat and loose tissue; and, in sawing the bone, it may be advisable, if the femur have not been very completely cleaned, not to pass the saw entirely through the osseous tissue, but rather to break than to cut the outer lamella at the back, by using the saw as a lever. The level at which the femur is to be divided should be carefully borne in mind in operating on children. I have repeatedly seen the surgeon take away the whole epiphysis and a part of the shaft from mere want of care, having forgotten, or omitted to ascertain, whereabouts this line is situated. Figs. 185, 186 show its true position, and will prove that in any case of excision in which the whole cartilaginous surface of the femur is removed, the shaft will be trenched upon.

FIG. 187.—Splint for Excision of the Knee.



The end of the femur having been removed, the head of the tibia is to be cleaned and sawn horizontally, care being taken in young persons to keep close below the cartilaginous surface, so that the epiphysial line be not interfered with. In cases where there has been no dislocation, nor much alteration in the shape of the bones from previous disease, there is now usually no impediment to placing the limb in a straight position, with the bones in accurate adjustment. Otherwise they must be adjusted by taking off successive pieces from the end of the femur or tibia (if possible without going beyond the epiphysis); and in cases of old dislocation it is often necessary to sever some of the hamstring tendons. All the diseased synovial membrane should be dissected away; and I have found it necessary to scrape out the synovial pouch above the patella with Volkmann's spoon, and pass a drainage-tube through an incision made into its upper angle. The parts should, in all cases, be adjusted in perfect position upon a splint, and the bandages firmly applied before the patient is moved or allowed to recover from the anæsthetic. If the femur

FIG. 188.—Dr. P. H. Watson's Suspension-rod for Excision of the Knee.



appears at all prominent, a short splint should be applied in front in order to counteract the tendency of the leg to gravitate backwards (which is also assisted by the action of the flexor tendons); and it is at any rate a useful precaution to apply a long side-splint to the outer side of the limb, which can be discarded after the first few days, if it appears superfluous. I have found much comfort to the patient from suspending the whole apparatus in a 'Salter's swing.' It will of course be understood that the splints are interrupted and bracketed with iron at the seat of operation, so as to give access to the wound.

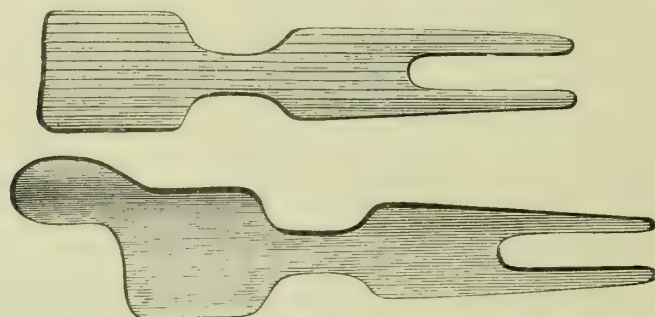
There are many other methods of dressing the wound and limb in cases of excision of the knee. Dr. Patrick Heron Watson warmly recommends the use of plaster of Paris (or plaster coated with paraffine externally, to render it less permeable to discharges), which he thus applies. Fig. 188 represents an iron rod, which extends from the groin to the foot, the upper straight end being at the groin, the arch at the site of the wound, the hook (for swinging the limb) near the ankle-joint, and the

raised part running along the dorsum of the foot. Fig. 189 shows two forms of 'Gooch' splint, the former merely hollowed out on each side at the level of the wound and cut out at the lower part in a horseshoe or stirrup form, to relieve the heel and tendo Achillis from pressure; the latter having also a piece above to be adapted to the innominate bone.

In application, the limb is first laid and carefully adjusted upon the posterior splint, which should preliminarily be padded with lint, and covered with gutta-percha tissue, or hot paraffine, in the position which corresponds to the site of operation. The iron rod is then placed in front, and folded lint laid between it and the limb at the groin, at the upper part of the tibia, and at the bend of the ankle. These two parts of the apparatus are then retained in contact with the limb by means of an *open wove* roller bandage applied from the toes upwards, the site of the incision being alone left uncovered. The whole is then rendered immovable by means either of plaster of Paris applied by the hand, of the consistence of thick cream, or of paraffine, which, having been rendered temporarily liquid by heat, is applied by a large painter's brush. When the application has solidified, the patient may be removed to bed, and the limb suspended from the running pulley of a Salter's swinging cradle, or from the roof-bar of the common iron-wire cradle.¹

The advantages claimed for this method are the comfort the patient derives from being able to shift his position, the ease of transporting him from place to place (a great consideration in military practice), the facility of applying dressings to the wound, the permanence, simplicity, and facility of construction of the apparatus itself. My own experience of this treatment is limited to a few cases, but these were sufficient

FIG. 189.—Dr. P. H. Watson's Splints for Excision of the Knee.



to convince me of the reality of its advantages in some cases. The plaster of Paris dressing is in general use in this and other excisions by the German surgeons. Its main disadvantage is the tendency in some cases to rapid shrinking of the limb, so that the plaster cast becomes loose. If from this or any other cause it is necessary to remove and renew the entire dressing, cutting off and remaking the plaster of Paris cast entails much trouble and disturbance of the wound. Most cases are now treated with Lister's dressing, and, on the whole, with extremely good results. The series of cases at Guy's Hospital above referred to (page 760) were, I believe, all treated in this way, and show a far more successful result than was ever before obtained in this operation.

It is an essential element in the success of this operation not to be forced to disturb the limb at all for several days; hence the dressings should be most carefully applied at first, and free drainage provided. And for the same reason all bleeding vessels should be carefully secured, so as to avoid secondary hæmorrhage. The bleeding from the enlarged articular vessels during the operation is often very free; and secondary hæmorrhage is by no means rare, and is a very unfavourable occurrence. The operation, especially when it has been a protracted one, which, in cases of old dislocation it often is, is usually followed by a considerable amount of fever, subsiding with the establishment of a free suppuration; and then, in favourable cases, the work of repair commences by granulation and osseous union, as in compound fracture. In unfavourable cases, the bones become denuded and ulcerated in the suppurating

¹ Dr. P. H. Watson, *On Excision of the Knee*, p. 16.

cavity, the discharge is offensive, the wound unhealthy, fresh abscesses probably form, and the patient's health, instead of improving from the removal of the disease, shows a tendency to decline. Under these circumstances, an anæsthetic should be administered and amputation performed, if on examination it proves necessary.

The process of recovery is slower than after amputation. This, however, is not the case to so great a degree in the present day, when (with or without Lister's dressing) efficient drainage is generally secured, as it was when the operation was first introduced. Consequently the details illustrating this point which were published in former editions of this work would no longer give an accurate view of the case. In some exceptional cases, indeed, matters go on rapidly, and the recovery is completed as soon as (indeed, it may be that one or two have recovered sooner than) after amputation; but it is still true that the recovery takes a much longer time on the average.

When recovery is rapid and ankylosis sound in the straight position, the limb is a very useful one, hardly less useful for progression than the other, except for the shortening. And even when there is a good deal of shortening, the limb is still very useful, as a striking case mentioned below will show. But these cases are such as obtain perfectly firm ankylosis, with no persisting sinuses, no pain about the parts, and no suspicion of any lingering disease in the bones.

No case is to be accepted as a successful one of excision of the knee without *precise* information as to the following facts: Whether the wounds were all closed; whether the union was so firm as no longer to permit any motion; whether the patient could walk, and, if so, with or without apparatus; and what were the respective measurements of the limbs.

As far as Dr. Hodges could discover from the data furnished by published accounts, out of 208 cases of excision, 102 failed utterly, as proved by death or amputation: and of the remaining 106 there was reason for thinking that in 65 cases the limb was useful, and in 14 partially or entirely useless, 27 being left quite doubtful; but from the nature of such accounts this conclusion cannot be a very confident one. Out of 19 cases occurring at St. Thomas's and St. George's Hospitals together, of which I have trustworthy and sufficient details, the limb was useful in 10 cases; but 9 of these were children.

The results of English practice, as far as he could ascertain them, from the invention of the operation down to a very recent period (not expressly specified) are thus tabulated by Mr. Swain in 1869:—

	No. of cases	Recoveries	Deaths	Amputations	Recoveries	Deaths
Recorded in Price's book up to 1865	316	240	76	39	30	9
Collected by Sir W. McCormac . . .	74	49	25	11	7	4
Tabulated by Mr. Swain himself . .	82	67	15	4	4	0
	<hr/> 472	<hr/> 356	<hr/> 116	<hr/> 54	<hr/> 41	<hr/> 13

Thus we have 472 cases, with a mortality of $116 = 24\cdot57$ per cent. Of the 356 who recovered from the immediate effects of the operation, 54 underwent subsequent amputation (13 of them dying), leaving 302 with useful limbs.¹

I give this table as Mr. Swain gives it, and cordially agree with him in his low estimate of the value of such statistical information. Such tables can in fact prove very little. They do indeed show that the mortality has diminished; but whether this has arisen from improved surgery—that is, from a better style of operating and after-treatment—or from a more indiscriminate application of the operation to cases of slighter disease which need not have been operated on at all, but in which the patients will of course be more likely to survive operation, neither is nor can be shown by statistics. It is also a somewhat suspicious feature in Mr. Swain's table that all the 302 recoveries are claimed as being with useful limbs. If the information had been at all adequately full, there would surely have been a category of recoveries with the limb more or less useless.

The table which I published in the 'British Medical Journal,' Aug. 14, 1880, shows the results of practice in some of the largest hospitals in England during five years ending 1878. It gives a total of 245 cases, with only 21 deaths directly from the operation, and 4 after amputation. Four cases were unaccounted for, and in 47 other cases the operation failed, most of them being amputated. This is a very much better result than in former times. It

¹ Swain, *op. cit.* p. 64.

is due no doubt in part to the operation having been largely used as one of expediency, and partly to improved methods of treatment.

Another very serious consideration in cases which recover with useful limbs is, whether that usefulness will be permanent. It is now a well-known fact that the utility of the limb in many cases in which it seemed perfect at first has been destroyed by subsequent changes. In adults, the union, although it has appeared quite firm,

FIG. 190.—Result of successful Excision of the Knee. (From a photograph.) To show the dropping of the pelvis on the affected side, by which the shortening is partly compensated, and the atrophy of the muscles of the thigh which follows on disuse of the knee-joint, while those of the leg are little affected.



sometimes proves not to have been so, and the limb bends under constant use, and yields to the power of the flexor muscles, until the foot no longer touches the ground, and the whole extremity becomes an incumbrance instead of a support. Sometimes it bows outwards or inwards, but with the same general result. Occasionally disease recurs, after a shorter or longer interval of apparent health, either spontaneously or as a consequence of some accidental injury or over-exertion.

Suspension of growth after excision of the knee in childhood is very liable to occur, and is usually caused by removal of the entire epiphysis,¹ with encroachment on the shaft of the femur, and possibly of the tibia also. I have already spoken of the precautions which ought to be taken in operating on children to avoid this, and I believe that in most cases the disease can be entirely removed and the epiphysal line left intact. But allowing that shortening occurs even to a very great extent, the limb may nevertheless be very useful. For a proof of this I would refer the reader to various cases published by myself and others which have been quoted by Mr. Swain,² and for the details of which I have not space here, and to some admirable remarks by Sir W. Fergusson in the sixth of his lectures 'On the Progress of Anatomy and Surgery,' illustrating the value in these cases of the preservation of the healthy leg and foot.

I recently saw a case in which I had operated nineteen years before, and where I had been obliged to remove the femur higher than the epiphysal line,³ and in whom therefore there had been progressive shortening. Although this shortening was nearly seven inches, he was a very good pedestrian, and had in fact walked thirty miles in one day just before he called on me. The shortening was partly compensated by a drop of about two inches of that side of the pelvis, and partly by a high-soled boot. The accompanying figure was taken from this case eleven years since.

The repair after excision of the knee may be illustrated by reference to the preparation represented by figs. 191, 192. It is true that this was not a completely successful

¹ Suspension of growth has, however, been noticed in one case at least, under Mr. Syme's care, where the epiphysal lines appear to have been left intact.

² *Op. cit.* pp. 141 to 148.

³ *Surgical Treatment of Children's Diseases*, 2nd ed. p. 486; *Brit. Med. Journ.* Aug. 14, 1880, p. 255.

case; but repair is very far advanced, and, had it not been for the visceral disease, it would, I doubt not, have been completed. As the case was under my own care, I may add that it serves also as an 'exemplar ad evitandum,' showing the deformity which is sometimes, in spite of all ordinary care, introduced into the union by displacement of the bones of the leg, and which both renders the limb less straight and comely, and doubtless tends to weakness in the union and subsequent displacement.

If the limb be simply bent in consequence of soft union, the only treatment required is to straighten it under anaesthesia, and keep it straight in a carefully-fitted splint for some months, with due attention to the general health, the patient being put in good pure air, and allowed to take moderate exercise upon crutches. When disease is present in the bones, it becomes a question whether the diseased bone can be removed, or whether the limb should be amputated. Some surgeons have even

Two Views of a Preparation, showing almost complete Repair after Excision of the Knee.
(From the Museum of St. George's Hospital.)

FIG. 191.

FIG. 192.

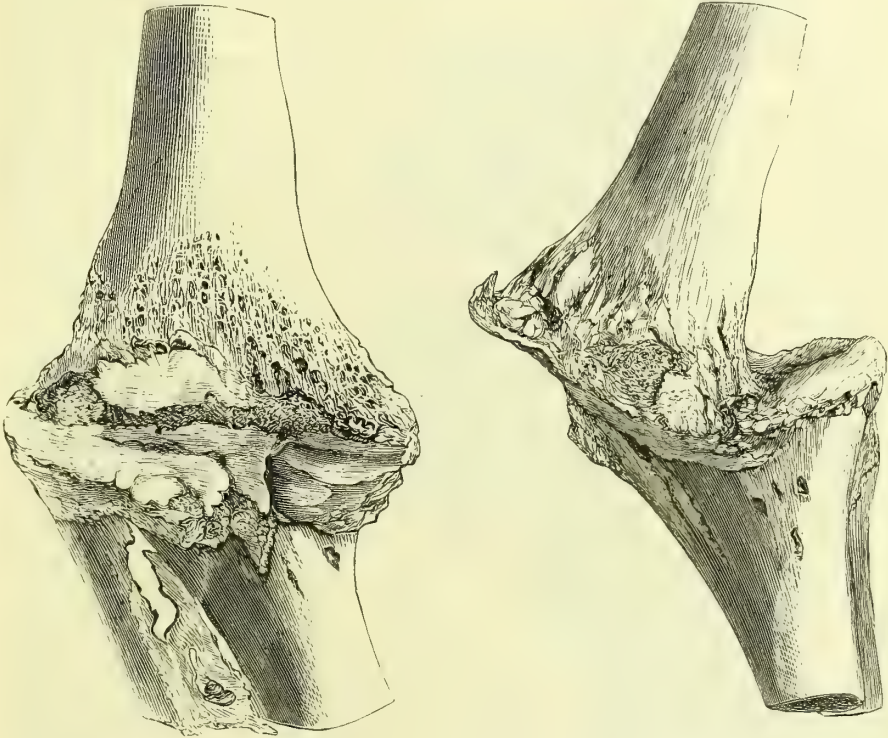


Fig. 191 shows the uniting medium almost perfect, but slight carious disease still going on in the bone. Fig. 192 shows the tilting backwards of the bones of the leg, or 'riding of the femur,' which is so liable to occur after this operation. The patient, a girl about the age of puberty, had nearly recovered from the operation, when signs of renal disease showed themselves, and she gradually sank.

proposed the complete re-excision of the false joint by an operation similar to the original one—a proposition highly worthy of consideration if the patient has attained his full growth and is in good health, and the shortening left by the first operation is not great. Such re-excision must, however, always be proposed to the patient as an exploratory operation, which in many cases will have to terminate in amputation.

Excision of the ankle.—This operation is one on which a wide difference of opinion prevails. There are many surgeons who have never practised or witnessed the operation, many who are entirely opposed to it on principle, believing amputation at the ankle-joint preferable; others who, after a limited and unsatisfactory experience of it, have abandoned it; and, lastly, others who, like myself, believe that it is very advisable and advantageous in appropriate cases, but believe, also, that those cases are rare. The cases to which I allude are those in which the disease is of traumatic

origin, and the patient in the vigour of life, unaffected by any constitutional malady. In such cases the inflammatory softening, or suppuration, does not usually extend far from the neighbourhood of the joint originally implicated, and after the removal of the diseased bone, the parts take on a healthy action, and become rapidly consolidated. In strumous disease, on the other hand, inflammatory softening, if not diffused suppuration, often exists in the tarsal bones or the bones of the leg, in parts not exposed to view in the operation; and in patients labouring under general constitutional affections, the parts operated on, instead of consolidating, usually soften, and after a long and exhaustive suppuration the bones are found carious, leaving no resource except amputation, and that sometimes under unfavourable circumstances. Again, as to the extent of the local disease. A case, to be strictly a favourable one for excision of the ankle, ought to be one in which the lesion is limited to the epiphysial ends of the bones of the leg on the one side, and to the astragalus on the other. Still, cases are on record in which most extensive excisions, involving the ankle-joint and more or less of the tarsus, have been followed by complete success,¹ but it must always remain a question in any given case whether the prospect of complete and speedy cure by amputation ought not to outweigh the doubtful chance of preserving a mutilated foot, which after all may be of little use, even should it continue free from recurrence of disease.

With respect to excision of the ankle for injury, I need say little as to the use of the operation in military surgery, since the question has already been treated in the essay on GUNSHOT WOUNDS, vol. i. p. 566. The successful experience, however, of Langenbeck in this operation, besides its special bearing on military practice, is also important in considering the general question of the advisability of attempting resection in preference to amputation in severe and incurable injury of the ankle. M. Ollier's experience, though not so extensive, is perhaps still more to the purpose in this respect, that it is gained entirely in civil practice.

He reports that he has practised resection three times for comminuted fractures of the lower ends of the bones of the leg.² In one case—a man 49 years of age—about one-third in length of the tibia was removed (12 centimètres = about 4 inches). The reproduction was not complete, but the patient recovered sufficient power to carry on his trade of a cooper. In the second case, 7 centimètres in length of both bones was removed. The patient, a midwife, was at the time of the report (length of time after operation not stated) able to walk with a stick and to attend to her business. In a third case, the patient died of cerebral complications produced by the same injury. A still larger portion of bone (16 centimètres) had been removed, and all was going on well as far as the operation went. M. Ollier also refers to another case under the care of MM. Jambon and Aubert (of Mâcon), where 10 centimètres of the tibia were removed; the patient had completely recovered, could walk ten miles, and dance for hours together.

Mr. Hancock, in his lectures at the Royal College of Surgeons in 1867, referred to numerous cases in civil practice in which excision of the ankle (or at least of the extremities of the bones of the leg) had been practised successfully on account of injury. Nineteen successful cases are referred to by Mr. Hancock (one of which is of peculiar interest, inasmuch as the operation was practised on both sides), and he mentions that 'Heyfelder gives 26 examples of this operation, of which 5 died, and 1 suffered consecutive amputation; while Jaeger, on the other hand, records 24 cases, 23 of which proved successful, and 1 died.'³

In almost all cases of excision for injury, the operation has been rather a resection of the fractured ends of the tibia, fibula, or both, than a complete excision of the ankle. Mr. H. Lee, however, has recorded a case of complete primary excision of the ankle in the 57th volume of the 'Medico-Chirurgical Transactions,' and rests his preference for this operation over the mere removal of the protruding or loose portions of bone on the more solid anchylosis obtained, when the section of the tibia is opposed to a similar fresh section of the astragalus instead of its cartilaginous facet.

These facts appear to demonstrate that in complicated injuries about the ankle,

¹ In one case referred to by Dr. Hodges, the ends of the tibia and fibula, the whole of the astragalus, part of the os calcis and the three cuneiform bones, were removed; in another the end of the tibia, the astragalus, scaphoid, and two of the cuneiform.

² *Des Resections des grandes Articulations.* Lyon, 1869.

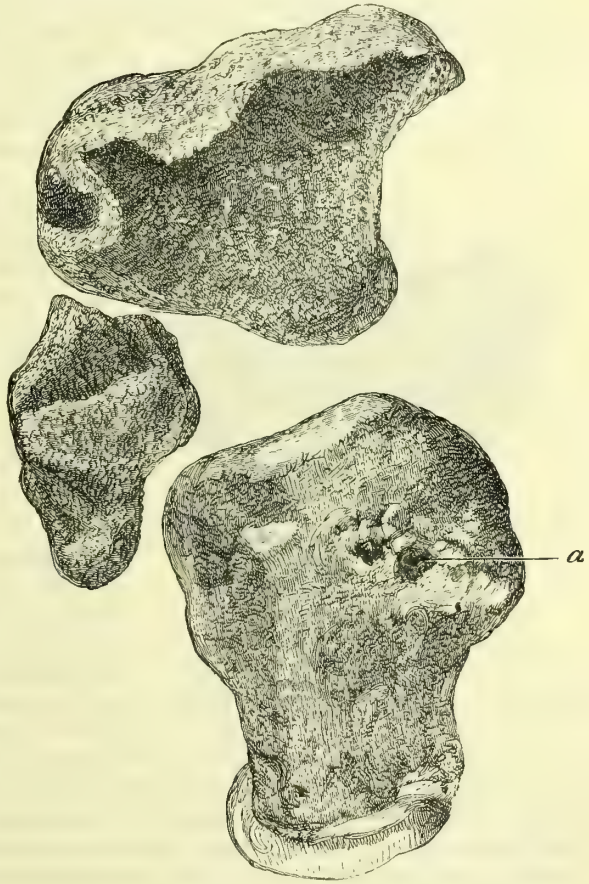
³ *Anatomy and Surgery of the Human Foot*, p. 338.

resection may be performed with good hope of success if the patient be healthy and if the after-treatment be judicious.

We are not in a position to lay down rules for the preference of excision over the expectant treatment, on the one hand, or amputation on the other. 'Each case,' as Mr. Morris says,¹ 'must be studied separately, and dealt with according to its special circumstances.' But I think that we may conclude, generally, that excision is preferable to amputation in young patients of healthy constitution and habits, and that it is preferable to the expectant treatment in cases of great comminution of bone associated with comparatively slight injury to the soft parts.

With regard to the operation itself, I cannot do better than quote Mr. Barwell's description of the operation, as originally devised by Mr. Hancock, and which is, as far as I know, the best operative procedure for the removal of the entire joint—that is to say, the ends of the bones of the leg and the articular surface, or, if necessary, the whole of the astragalus. 'The foot is first laid on its inside, and an incision is made over the lower three inches of the posterior edge of the fibula. When it has reached the lower end of the malleolus, it forms an angle, and runs downwards and forwards to within about half an inch of the base of the outer metatarsal bone. The angular flap is reflected forwards; the fibula, about two inches above the malleolus, is sufficiently cleared of soft parts to allow cutting forceps to be placed over it; and the bone is then nipped in two and carefully dissected out, leaving the peroneus longus and brevis tendon uncut. The foot is now to be turned over. A similar incision is made on the inner side, the portion on the foot terminating over the projection of the inner cuneiform bone. The flap is to be turned

FIG. 193.—Bones removed in Excision of the Ankle, showing the ends of the Bones of the Leg and the upper surface of the Astragalus.



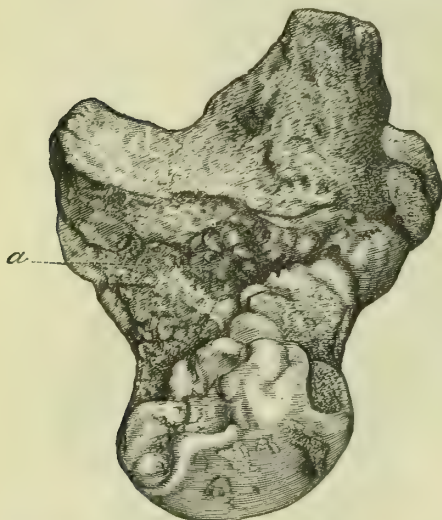
back, and the sheaths of the flexor longus digitorum and posterior tibial tendon exposed, the knife being kept close to the bone, avoiding the artery and nerve. The internal lateral ligament is then to be severed carefully, close to the bone; and now the foot is twisted outwards, and the astragalus and tibia will present at the inner wound. A narrow-bladed saw, put in between the tendons into the inner wound, projects through the outer. The lower end of the tibia, then the top of the astragalus, may be sawn off in a proper direction. The only vessel that may require tying is one of the lower branches of the peroneal artery. The wound may be closed with sutures, except that part opposite the breach of osseous matter; the leg and foot placed on a splint with a foot-board, and cold water applied.'

¹ 'Dislocation of the Foot' in *INJURIES OF THE LOWER EXTREMITY*, vol. i. p. 1094.

Dr. M. Buchanan has also described ¹ an operation for excising the ankle-joint, by making a curved incision over the external malleolus, removing this process with the bone-forceps, dislocating the joint by inverting the sole of the foot, and thus obtaining access to the diseased bones without dividing any important parts, the peronei tendons being the only structures necessarily divided. This proceeding is merely a portion, as it were, of the one described by Mr. Barwell. It cannot give so free an access to the bones as is obtained by the former; but it may be adopted in cases where the end of the tibia does not require entire removal with the saw. The operation may, therefore, be commenced by making merely the incision on the outer side; and then, if it be found necessary, that on the inner side may be added. Mr. H. Lee recommends to make a small incision over the internal malleolus, which is to be sawn off, and then to make the chief incision on the outer side, and dislocate the tibia outwards after the removal of the external malleolus. For my own part, however, I prefer very free incisions in this operation.

Langenbeck and Ollier have preferred the subperiosteal method of operating, and for the removal of large portions of bone in recent injuries there can be no question that this method should be preferred. In disease I think the subperiosteal method

FIG. 194.—The Lower Surface of the Astragalus from the same case as fig. 193.



The letter *a* in this and the previous figure shows the pit made in the astragalus by the grasp of the lion-forceps.

is of little consequence, because I do not believe that any large quantity of bone could be removed with success, unless for necrosis, when the periosteum would probably separate of itself. If only a small slice of the bones of the leg were removed, I should think it a matter of little consequence whether reproduction occurred or no. No express directions are needed for the subperiosteal operation beyond those already given.

I have elsewhere ² pointed out the advantages which are to be derived from the removal of the entire astragalus in cases where that bone is at all extensively affected. In fact, whenever the disease appears to have commenced in the astragalus, I think it is better to remove the whole bone; and still more is this the case if the sides of the bone are ulcerated and freely exposed, since in such circumstances the lower surface will also probably be found affected. Such was the case in the instance

to which I refer, and from which figs. 193, 194 are taken. They show the implication of all the articular surfaces of the astragalus, except that of its head, in the ulceration. The removal of the whole astragalus requires free incisions, and is somewhat laborious, but it affords complete access to the upper surface of the os calcis, which can be removed, if necessary, with the chisel, and even to the anterior part of the tarsus, if it should be judged necessary to deal with this. In the after-treatment, perfect rest of the foot is essential until the parts are somewhat consolidated. When this is effected, the foot may be supported on a splint, and the patient be allowed to go about, resting the knee on a wooden leg. I have hitherto treated my patients in the way which is common, in compound fracture of the leg, at St. George's Hospital, viz. by confining the foot and leg in Assalini's fracture-box, dressing the wounds at first with carbolic acid on Mr. Lister's plan, and at a later period—when suppuration has been fairly established, and the acute inflammation has subsided—with oakum. Langenbeck insists strongly on the advantages of the plaster of Paris splint in these cases, as in so many others, and I am informed by Dr. Patrick H. Watson that he has combined with the gypsum bandage a

¹ *Glasgow Medical Journal*, vol. ii. p. 1.

² *St. George's Hospital Reports*, vol. iv.

suspension-rod similar to the one which he uses for excision of the knee (see p. 761), but without any splint. Professor Esmarch, of Kiel, has also adopted Dr. Watson's plan, and both surgeons have found the results very satisfactory.

In cases of successful excision, the limb is very much superior in usefulness to any stump which can be formed, whether by Syme's or any other method of amputation.

One of these successful cases was exhibited at the Pathological Society in 1863. The excision had been performed, several years before, by Mr. Hancock. The foot was firmly ankylosed to the bones of the leg, and at a perfectly convenient angle. The shortening was but slight, and the man could walk almost as well as ever.

Fig. 195 was taken from a case in which I excised the ankle-joint in 1869. His condition was thus reported by my friend, Dr. Nicholls, of Chelmsford, near whom he resided, in 1871: 'The operated leg is slightly shortened; all the wounds are healed; he walks, with the aid of a boot with irons, as much as half a mile, without inconvenience.' In this instance the disease was abscess of the lower end of the tibia, bursting into the joint. Only the upper part of the astragalus was removed, that bone being quite healthy.

An interesting case is reported by Dr. Murney in the 'Dublin Quarterly Journal' for February 1870, in which the left ankle-joint had been completely excised eleven years before. The patient's state is thus described: 'He is now 27 years of age, muscular and strong, has enjoyed uninterrupted good health since he left hospital; is active and fond of walking, and considers the left is stronger than the right limb; does not use a stick; in progression there is a slight halt, but not more than is frequently observed from a corn. This, to the ordinary observer, would be attributed to a slight *in-turning* of the toes of the left foot, as when he walks the right foot is turned out, the left is placed straight. On examination, there is considerable deposit of new tissue between the bones which were cut. The foot is slightly extended. This makes the toes and anterior part almost of proper length, but the heel is $1\frac{1}{2}$ in. higher than its fellow, which he remedies by placing a wedge-shaped piece of cork in the heel of his boot. The power of extension of the toes is as complete as in the opposite limb, and sensation is also perfect.

FIG. 195.—Result of successful Excision of the Ankle.



On the other hand, cases occur in which the result appears good for the time, but the success turns out to have been only temporary; the wounds, after healing, break out again, and local, perhaps combined also with general, disease reappears. I do not know that this is more particularly the case after excision of the ankle-joint than after any other of these operations.

Excision of the bones of the foot.—In disease of the tarsal or metatarsal bones excision is often very successfully practised when the disease is limited to the os calcis behind, or to single bones of the metatarsus in front; but it is of more doubtful utility when the bones which are affected are those covered by the large common synovial membrane of the tarsus. These bones, both from their small size and from being portions of the same joint, are very liable to become involved in the same action, and thus it frequently happens that disease is only eradicated at one point to show itself some weeks afterwards at another, and the attempt to save the foot is often unsuccessful. But in favourable cases it ought to be made, since the operations involve little danger, and no confinement beyond what would be rendered necessary by the disease itself. Many surgeons prefer gouging out the whole carious cavity, leaving a shell formed of bone presumed to be healthy, and of the soft parts around; an operation sometimes dignified by the name of 'subperiosteal resection,' and described by M. Sédillot under the name of 'évidement de l'os.' The alleged advantages of this proceeding are, that the bone may be reproduced, and that the great tendons will be left in their natural attachments. I do not attribute very

much importance to either of these considerations. No direct evidence, as far as I can discover, has been given that the natural bone will be reproduced after such gouging. I mean by 'the natural bone,' a bone which will fill up the place of the original bone, and have the same articulations; and by 'direct evidence,' the dissection of a foot in which this has taken place. The disadvantages are all of them summed up in the fact of the difficulty of being sure that the whole of the diseased bone has been removed. When the whole of the os calcis, of the astragalus, or of the first metatarsal bone, has been involved, except a small exterior portion of dubiously healthy bone, I have not scrupled to dissect out the entire bone without respect to the periosteum, and have seen no reason to repent having done so. The foot has been left in a very serviceable condition; and I much doubt whether the addition of a few detached pieces of bone to the cicatrix (which I believe would have been the entire result if the periosteum had been left behind) would have affected the usefulness of the foot in any way.

Excision of the joints between the os calcis and astragalus.—Disease of the tarsus not uncommonly originates in the articulations between the astragalus and os calcis. (See the essay on DISEASES OF THE JOINTS, vol. ii. p. 390.) It is only rarely that the surgeon obtains the opportunity of treating a case in which the disease is limited to these articulations, yet is so far advanced in them as to justify operation. It seems, however, that in such cases it is not impossible to remove the whole of the articulating surfaces and preserve a useful foot. This ingenious operation was devised by Mr. Annandale, who thus describes it:—"The foot having been placed in the extended position, and resting on its inner aspect, an incision, commencing about an inch above the tip of the external malleolus, and carried along its posterior border in a curved direction to the calcaneo-cuboid joint, thoroughly exposes the posterior and external portion of the joint, when the peroneal tendons have been drawn outwards, and some ligamentous bands divided. This incision will be found to run along the inner border of the tendon of the peroneus brevis muscle. The anterior and internal portion of the joint can then be exposed by placing the foot still in the extended position on its outer aspect, and making an incision from the tip of the internal malleolus along the course of the tendon of the tibialis posticus, as far as the prominence of the scaphoid bone, drawing forwards this tendon and carefully drawing backwards the other tendons and the posterior tibial vessels and nerve. By making the first incision through the skin and cellular tissue only, and so ascertaining the exact position of the tendons likely to be injured, then cutting down through the periosteum to the bone, and with a periosteal scraper separating to a sufficient extent the periosteum, together with all the other superficial tissues, there is little risk of injuring any of the tendons or other important structures. Both aspects of the joint having in this way been exposed, it will be found that by means of the chisel and mallet the articular surfaces can be easily and accurately removed, the posterior portion being removed through the external incision, and the anterior portion through the internal one. Should there be any disease in the hollow or fossa between the two articular surfaces, it can be readily reached and removed with the chisel or gouge through either of the incisions."¹

Excision of the os calcis is an operation which may often be practised with great advantage. Many cases occur in practice in which, either as the result of injury to the bone itself, or of disease of the joints between it and the astragalus, the central part of the calcaneum perishes, leaving a large mass of necrosis enclosed in a thin-walled cavity of inflamed and softened bone. If now, the whole bone, including this shell of softened bone, be removed, the patient makes a certain and speedy recovery with a useful foot; while if the loose portion be removed, and the shell scooped, he may, it is true, recover, and the heel may possibly be more firm, but the recovery is at least doubtful, and in the course of a tedious convalescence the health may give way, fresh disease be lighted up, and amputation become necessary.

¹ *Edinburgh Medical and Surgical Journal*, January 1877.

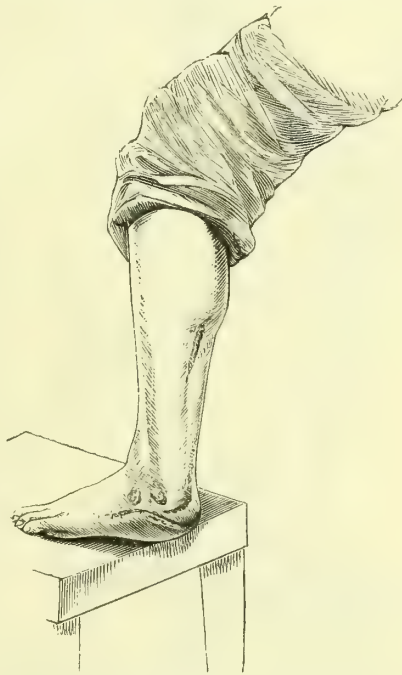
Excision of the os calcis is thus performed. An incision is commenced at the inner edge of the tendo Achillis, and drawn horizontally forwards along the outer side of the foot, somewhat in front of the calcaneo-cuboid joint, which lies midway between the outer malleolus and the end of the fifth metatarsal bone. This incision should go down at once upon the bone, so that the tendon should be felt to snap as the incision is commenced. It should be as nearly as possible on a level with the upper border of the os calcis; a point which the surgeon can determine, if the dorsum of the foot is in a natural state, by feeling the pit in which the extensor brevis digitorum arises. Another incision is then to be drawn vertically across the sole, commencing near the anterior end of the former incision, and terminating at the outer border of the grooved, or internal, surface of the os calcis, beyond which point it should not extend, for fear of wounding the posterior tibial vessels. If more room be required, this vertical incision may be prolonged a little upwards, so as form a $+$.¹ The bone being now denuded, by throwing back the flaps, the first point is to find, and lay open, the calcaneo-cuboid joint; and then the joints with the astragalus. The close connections between these two bones constitute the principal difficulty in the operation on the dead subject; but, as has been already stated, these joints will frequently be found to have been destroyed in cases of disease. The calcaneum having been separated thus from its bony connections by the free use of the knife, aided, if necessary, by the lever, lion-forceps, &c., the soft parts are next to be cleaned off its inner side with care, in order to avoid the vessels, and the bone will then come away. The flaps are to be closed lightly, with one or two points of wire-suture, over the large gap left by the excision.

This plan appears more convenient and less bloody than that recommended by Mr. Hancock and Mr. Guthrie, of making a flap from the heel and throwing it up, as done in Syme's amputation. Even if the diagnosis has been erroneous; if disease should become apparent in the astragalus or in the fore-part of the tarsus, when the bones are denuded, and so the surgeon should be led to amputate the foot, that operation could be easily accomplished by a slight extension of the incisions just described. In this way I have often removed the os calcis in a very short

time, and without finding it necessary to tie a single artery. The filling up of so large a cavity is of course a rather tedious business; in most of the cases of which I have notes, recovery was not completed in less than three months; and probably the patient does not recover the power of putting the foot to the ground for another month or more. But when it is soundly healed, the foot is a very useful one; and I have seen children who could run, dance, &c. pretty nearly as well as with the natural foot. The heel is a little elevated, as in fig. 196, otherwise there is little deformity.

M. Ollier describes an operation by which the os calcis can be removed subperiosteally without the division of any tendons, except the tendo Achillis. An angular flap is made by an incision running horizontally along the lower outer border of the bone, and vertically along the outer border of the tendo Achillis. Then the

FIG. 196.—Drawing from the Photograph of a Patient in whom the Os Calcis, almost the whole Astragalus, and a portion of the Scaphoid Bone, had been removed by Dr. Nicholls.



¹ I have always divided the tendons of the peroneus longus and brevis. They can, of course, be dissected out and held aside with a blunt hook, but I have not observed any bad effects from their division.

periosteum and the parts above it, including the peronei tendons, are peeled off the bone. Next the attachment of the tendo Achillis and the periosteum are detached from the tuberosity of the os calcis. Then the joints are opened, and the inside of the bone is cleaned, and so its removal is completed. My own experience of this subperiosteal operation is limited to a single case, in which, though a useful foot was obtained, yet the result was distinctly inferior to that of the common operation. The case and the dissection of the foot on the patient's death some years afterwards will be found in the 'Clinical Transactions,' vol. viii. p. 77, and vol. xi. p. 117.

Even when the astragalus is also diseased, the foot may be perfectly useful after the removal of both the diseased bones. Thus, at the Medico-Chirurgical Society of Edinburgh, December 1869, Dr. Watson showed a cast taken recently from the foot of a boy on whom he performed excision of the astragalus and os calcis, in July. The cast showed how a dense mass of tissue occupied the gap resulting from the operation. The posterior portion of the arch of the foot being gone, of course the patient could not expect to retain the spring of the foot; but in spite of this, not only was walking easily effected, but the foot, as was seen, presented a most seemly appearance.¹

A somewhat similar case occurred in the practice of Dr. Nicholls, of Chelmsford, the os calcis, almost the whole astragalus, and a portion of the scaphoid, having been removed in two operations. The patient can walk quite well and with a hardly perceptible limp; the appearance of the foot is shown in fig. 196.

A patient under my own care at St. George's Hospital recovered a useful foot ultimately after the excision at two different operations of the entire os calcis and astragalus; but after a very tedious convalescence. Dr. Macnaughton Jones has published a remarkable case in which the malleoli and *all* the tarsal bones were excised subperiosteally, and the patient (a child) recovered a useful foot, and could walk a year after the operation.²

Excision of the astragalus.—The astragalus is easily removed by making a curved incision from one malleolus to the other, something like that made at the beginning of Syme's amputation. The ankle-joint is then to be laid freely open, and the whole upper part of the diseased bone thus exposed. Then the ligaments connecting it to the scaphoid are to be severed, and the bone is to be levered up, when the interosseous ligament connecting it with the os calcis will, if entire, be felt, and can be readily divided. All that is then necessary to complete the operation is to clean the back part of the bone, which should be done with care, in order to avoid injury to the tendons and vessels which lie near it. I have had several cases in children, and have seen one in an adult in whom a very useful foot was left; one of these is represented in fig. 197.

FIG. 197.—The Foot after Recovery from Excision of the Astragalus. In this case the scaphoid bone, which had become ankylosed to the astragalus, was also removed.



The bone may also be removed by two lateral incisions similar to those used in excision of the ankle. This avoids the injury to the tendons and vessels incidental to the above method; but is more laborious.

No formal directions are required for excising the other tarsal bones. The soft parts are to be thrown aside by crucial incisions, radiating from the sinuses which lead to the diseased bone, and the latter removed; care being taken, in all cases where it is possible, to excise the whole bone with the articulating surfaces.³

The metatarsal bone of the great toe is very often diseased; and from its large size disease may go on in its substance for a long period without affecting any other bone. In such cases, after a sufficiently patient trial of the appropriate constitutional treatment, with rest, it is proper to expose the disease; and if this is found to include the greater part of the bone, then the best course is to remove the whole, with both

¹ *Edinburgh Medical Journal*, January 1870.

² *Clinical Observations on Surgical Cases*. Reprinted from the *Lancet*, July 9 and 16, 1881.

³ I would refer the reader to a paper on 'Excision of Isolated Bones of the Tarsus,' by Dr. G. Buchanan, in the *Edin. Med. Journ.* April 1876.

its articular surfaces. This may be readily done by making an incision over the whole length of the bone, joined by shorter perpendicular cuts in front and behind, and thus turning back small rectangular flaps including the whole length of the bone. It is better to commence by severing it from the cuneiform bone, as in dividing it from the phalanx the plantar arch will most likely be wounded, and the bleeding may prove somewhat embarrassing; whereas if the artery be not divided till the bone is removed, there is no difficulty in tying it. No splint is required. The great toe sinks down somewhat towards the tarsus, but the foot is as useful in progression as before.

Should single metatarsal bones in the centre of the foot be diseased, it is better to gouge away the whole of the diseased part; or if the affection seems too extensive, to amputate the toe, and dissect out the metatarsal bone from the posterior end of the wound.

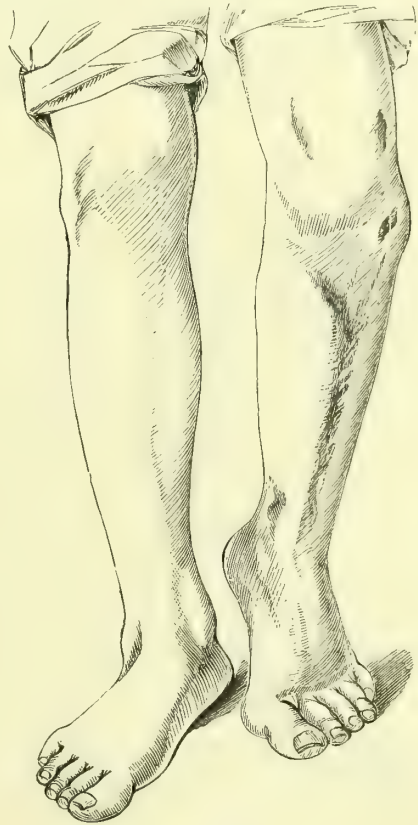
The above are all the operations of excision which it seems necessary to describe particularly. Dr. Humphry has removed the condyle of the jaw; and the same surgeon on one occasion excised a fractured portion of the patella; but the superficial position of these bones, and the rarity of the operations, render any formal description superfluous.

The operations on the upper and lower jaw have been described in connection with the surgery of that part of the body.

Total or partial resections of long bones.

When the entire thickness of a long bone is diseased, it may sometimes be advantageous to remove the diseased portion only. In this way portions of the ribs have been resected on account of caries, probably in order to avert the occurrence of pleuritic inflammation from the neighbourhood of the diseased bone; an operation of some risk and very doubtful utility; and more recently in order to give a free opening in cases of empyema.¹ Or portions of the shafts of the ulna, radius, tibia, or fibula have been cut out, with a view of promoting the healing of ulcers that seemed otherwise incurable, or getting rid of an obstinate affection of the bone. Many operations for necrosis are also erroneously entitled resections of the shafts of the bones, when they are really only extractions of sequestra; but in a few cases the necrosed shaft has been removed while yet connected to the living bone. Such

FIG. 198.—From a Boy in whom the whole of the Diaphysis of the Tibia had been removed. To show the shape of the limb after reproduction of the bone, and the extent of the resulting shortening.



¹ This is an operation which is now common enough, and more especially in children. Its main object is to allow the chest-wall to fall inwards towards the lung, which is bound down more or less completely to the spine and posterior wall of the thorax; though the other object, that of providing a more complete opening for drainage, is also important, and occasionally justifies its adoption in adults. One of the lower ribs (the seventh or eighth) is usually selected, and a piece between one and two inches long is removed, by making an incision down to the bone, carefully rasping it free of all soft parts, including the periosteum, and then sawing it through partly from above, and completing the section with bone-nippers. In this way the intercostal vessels and nerve will escape injury. Some surgeons prefer to remove a smaller piece of two contiguous ribs.

operations, however, whether undertaken on account of caries or necrosis, too often result in failure. In cases of necrosis of a portion of the thickness of a bone, resection should very rarely be practised—perhaps we might say never, unless for the relief of inflammatory symptoms propagated from the diseased bone to neighbouring organs. Nor, in cases of necrosis of the whole thickness of the shaft, is it usually advisable to operate until the old shaft has separated from the new bone. No special directions are needed for these operations. The chief point to be attended to is to keep as close to the bone as possible, in order to spare not merely the tendons, vessels, &c. which may lie in relation with the diseased bone, but also the periosteum; so that there may be as good a prospect as possible of the regeneration of the part removed.

FIG. 199.—From a case in which three inches and a half of the Shaft of the Femur had been removed subperiosteally. The knee became ankylosed from the extension of suppuration into the joint. The first figure shows the amount of the resulting shortening, which is confined entirely to the femur. The cicatrix on the inner side is the mark of an abscess. The posterior view of the limb shows the position of the wound from which the bone had been extracted, and the deformity produced by the ankylosis.



Subperiosteal excision of the shafts of long bones.—In cases of diffuse periosteal abscess, it will occasionally happen that the whole thickness of the shaft of the bone perishes, and becomes separate, or separable with very trifling force, from the adjoining bone, whether at the epiphysal lines, or at some part of the continuity of the diaphysis. In such cases the old practice was either to amputate, or to persevere in the expectant treatment until a sufficient periosteal deposit of bone had formed to restore the integrity of the shaft and support the muscular movements. I have in another essay² expressed my conviction that the latter plan of treatment should be abandoned, and that it is better, speaking generally, to remove a dead piece of bone

¹ DISEASES OF THE BONES, vol. ii. p. 303.

whenever it is possible, without waiting for osseous reproduction. There are also cases, as I believe, where the subperiosteal resection of the whole shafts, or of large portions of the whole thickness of the shafts of the long bones, will much improve the patient's prospects of recovery, and in all probability obviate the necessity of amputation.

Many striking cases illustrative of the advantages of this operation have now been put on record. I may refer to a case of a boy, aged 10, in which I removed the whole diaphysis of the tibia, which had separated from both its epiphyses, one month after the commencement of acute periostitis; to another in which I removed a portion, three inches and a half in length, of the shaft of the femur about four months after the commencement of the disease and before any periosteal bone had formed (fig. 199);¹ to another in which Mr. Joseph Bell, of Edinburgh, resected a still larger portion of the femur;² to a striking case by Dr. Cheever,³ of Boston, U.S., of resection not only of the whole diaphysis, but also of the lower epiphysis of the tibia, at the age of 13, where nine inches of bone was removed, the ligaments of the ankle-joint divided, and the articular end of the tibia formally dissected away from the fibula and astragalus, good motion resulting; to a case under my own care,⁴ where eight inches of the shaft of the tibia was removed with success, although it was necessary to saw through the living bone above, and although the abscess had burst into the ankle-joint below; to three cases which may be found in M. Ollier's work, above referred to, under the care of Letenneur, Larghi, and Crus y Manso, in which the whole diaphysis of the tibia was successfully removed; and to a still more remarkable case by Bockenheimer in the '*Deutsche Med. Wochensch.*' 1879, Nos. 50, 51, where the whole femur was extirpated, from the hip to the knee, with reproduction of the bone and a useful limb.

In all these cases, in which the whole thickness of the bone is removed for any considerable length, it appears to me, as far as I can discover, that shortening always ensues when the bone is solitary, as the femur; and almost, if not quite always, when it is the chief bone of the limb, as the tibia.⁵ The head of the fibula in these cases experiences a gradual displacement upwards. When it is the subordinate bone, as the fibula, or of equal rank, as one of the bones of the forearm, the other bone prevents the necessary approximation of the parts under muscular contraction, and the reproduced portions of the bone do not unite. Such, at least, has been my experience, but the cases are as yet too few to justify any confident general statement.

The operation is usually one of extreme facility. A very free incision should be made along the superficial aspect of the bone, and the periosteum separated by means of the handle of the scalpel, or other blunt instrument. This being done, a chain-saw is to be passed under the bone, and its divided ends seized with the lion-forceps and gently twisted. If they will come away from the epiphysal lines, the operation is over; otherwise the chain-saw must be again applied at the limits of the separated periosteum. If the articular end is also to be removed, its ligaments must of course be divided. It is far more satisfactory to find the separation of the dead bone already complete, than to have to make the division of the dead bone from the living with the saw, though in some cases, as in my own above referred to, the latter proceeding has proved successful.

Space hardly allows of a proper discussion as to the propriety of such operations as these under different circumstances. In all the instances referred to the operation succeeded. In one, in which I removed a portion only of the shaft of the tibia, it failed, and amputation became necessary, the patient recovering. But the cases have been too few at present to enable us to judge as to the relative safety of this course and amputation. All that I will say here on the subject is, that in early life (and most, if not all, these cases occur in childhood), when the whole thickness of the shaft of the bone perishes in consequence of acute periosteal abscess, and is separable from

¹ *Surgical Treatment of Children's Diseases*, 2nd edit. pp. 391, 395.

² *Brit. Med. Journ.* May 2, 1868.

³ *Surgical Cases*, by D. W. Cheever, M.D., p. 15; Boston, 1869.

⁴ *St. George's Hospital Reports*, vol. x. p. 500.

⁵ In a case, however, recorded by Mr. W. Pye (*Proc. of Royal Med.-Chir. Soc.* vol. viii. p. 434) the patient recovered with inappreciable shortening after the resection of the whole diaphysis of the tibia.

the neighbouring portions, subperiosteal excision appears to me to be indicated, and should be performed at the earliest possible period. Many of these cases terminate in the most gratifying manner; and a patient who would otherwise have been condemned to amputation, or have lost his life by pyæmia, rapidly recovers from the profound surgical fever which accompanies this complaint, and regains a very useful, though somewhat shortened limb. In less acute cases, where the amount of bone which has perished is smaller, and the surgical fever does not run so high, the expectant treatment is certainly justifiable and may often be advisable.

TIMOTHY HOLMES.

APPENDIX.



SURGICAL DISEASES OF CHILDHOOD.

THE surgery of the diseases of childhood naturally divides itself into three different classes, viz. the pathology and treatment of, 1. Malformations; 2. Injuries and their sequelæ; 3. Diseases. The purport of this essay is not to give a complete account of each of these subjects, inasmuch as many of their topics have been treated elsewhere; but to indicate the matters with which the surgery of childhood is principally concerned; to point out to the reader whereabouts in this work such of those matters as have been included in previous essays may be found; and to give a short account of those which have not been elsewhere treated.¹

It is a very well-known fact that children will sometimes bear severe accidents or surgical operations without any injury to their general health; while at other times much slighter injuries or operations are followed by very alarming symptoms, and sometimes even by death, although the child does not seem unhealthy, and is not much reduced by disease; so that children are sometimes said to bear operations better than adults, and sometimes the reverse. It is not always easy to explain this discrepancy; but the main principle to be borne in mind in operations on children seems to be this—that children bear the loss of blood, and all other causes of sudden shock, worse than adults; but bear protracted suppuration and long confinement to bed better, and are far less liable to the secondary complications of wounds. Erysipelas in its milder form is not very rare in children's hospitals, where the spreading or ulcerative variety of phagedæna may also be occasionally seen; and the condition usually known as diffuse phlebitis is also met with, though more rarely; but pyæmia, though not unknown, is exceedingly rare; and diffuse cellular inflammation (or phlegmonous erysipelas) is almost, if not quite, unknown.

Our first care in operations on children must be to avoid shock. Hæmorrhage is the chief cause of shock, where anæsthetics are used; but when this is not the case, pain, terror, and struggling are also most efficient causes of prostration, and more especially in protracted operations. Even when the child is under anæsthesia, a very protracted operation is liable to be followed by prostration—both because long operations generally involve the loss of much blood, and because the prolonged administration of an anæsthetic is itself a very serious cause of depression. But operations in children are often made longer by the necessity which there is for examining the parts at the time of the operation, since the child will not permit this to be done without the anæsthetic. In all cases, however, in which it is possible, this examination should be performed a few days previously; and the surgeon should come prepared to begin the operation at once. If the proceeding is of such a nature that the child must necessarily be kept for a long while under the influence of the anæsthetic, it seems a good plan to administer a stimulant a little while before, such as a glass of wine or a little sal-volatile.

This mention of the grave symptoms which may follow upon the pain and shock of an operation naturally introduces the consideration of the administration of anæsthetics in childhood. No department of surgery has profited more by the discovery of anæsthetics than that

¹ The following list comprises most of the topics in the foregoing pages which relate exclusively to diseases peculiar to, or more usually met with, in childhood: Noma, or cancerum oris, vol. i. p. 142; Trismus nascentium, p. 200; Scrofula, p. 216 et sqq.; Congenital cutaneous cysts, pp. 257–259; Vascular tumours, p. 270; Burns and scalds, p. 387 et sqq.; Separation of epiphyses, p. 408; Incomplete fractures, p. 410; Depressions of the skull, p. 582; Foreign bodies in the ear, vol. ii. p. 132; and in the nose, vol. i. p. 717; Burn and scald of the larynx, pp. 751 et sqq.; Foreign bodies in the air-passages, p. 756; Laryngotomy and tracheotomy, p. 772; Rupture of the thoracic viscera, without wound, p. 859; Rupture of the urethra, p. 926; Dislocation of the head of the radius, p. 985; Supernumerary auricles, vol. ii. p. 131; Orthopædic surgery, p. 227 et sqq.; Diffuse periostitis, p. 282; Scrofulous disease of bone, p. 303; Scrofulous disease of joints, p. 342; Hip-joint disease, p. 363; Spinal disease, p. 401; Tongue-tie, p. 553; Gumboil, p. 447; Congenital hypertrophy of gums, p. 456; Exanthematous jaw-necrosis, p. 480; Diphtheria and croup, p. 620 et sqq.; Enlarged tonsils, p. 492; Cleft palate, p. 498; Nævus of lips and cheeks, p. 317; Congenital cysts of the mouth, p. 523; Congenital malformation of intestines, p. 711; Intussusception, p. 719; Congenital hernia, p. 752; Prolapsus of rectum, p. 842; Polypus of rectum, p. 864; Extroversion of bladder, vol. iii. pp. 180 and 688; Incontinence of urine in children, p. 192; Hypospadias and epispadias, pp. 207 and 686; Stone, p. 235 et sqq.; Congenital malformations of vagina, p. 393; Imperfect development and retention of testis, p. 461 et sqq.; Congenital hydrocele, p. 490; Means of strangulation of nævi, p. 657; Harelip, p. 676; Contracted cicatrices, p. 691. Besides these, all affections of the eye, the ear, the skin and its appendages, and the various excisions, will be found in the essays devoted to those subjects.

which is concerned with children's diseases. It is very frequently quite impossible to examine a diseased joint satisfactorily and thoroughly, to sound for stone, or to perform any other examination which either lasts long and produces pain, or which requires quiet and silence, without rendering the child unconscious. Hence the administration of ether and chloroform is of daily occurrence in our children's hospitals; and the very great rarity of accidents from such administration shows that in all essential particulars chloroform (which is the anæsthetic usually employed) is as safe as it is certainly efficient. But chloroform often causes unpleasant, and sometimes even alarming, symptoms; and although I have not yet had the misfortune to witness a fatal result, I saw one case in which the patient was only revived by a vigorous application of restorative measures from a condition of apparent death. The unpleasant symptoms referred to are chiefly the rapid fluctuations of pulse, and the tendency to sudden congestion and stertor. If these threatening symptoms be overlooked, and chloroform still given, the pulse and respiration may be suddenly suspended, and alarming or even fatal symptoms ensue. So that it is always necessary to watch the pulse closely, and to give chloroform with great caution in children, even when they breathe it quietly; and still more when, from their struggling and crying, the anæsthetic is taken in irregular and often very full doses. Usually after such struggles the child passes almost at once into an insensible condition; and, as soon as this occurs, the chloroform should be administered only to such an extent as to prevent struggling. Both children and grown people when under chloroform will give indications of pain, while the real feeling of pain (at least if tested by the patient's remembrance of the operation) is quite absent. It is therefore not necessary for the comfort of the patient that every movement and every sound indicative of pain should be suppressed.

When asphyxia comes on, prompt measures will almost always save the patient. The tongue should be at once pulled as far as possible out of the mouth with a pair of forceps, and artificial respiration should be resorted to. Whatever difference of opinion may exist as to the most effectual method of performing artificial respiration in other cases, I should think that a very little experience would convince anyone that in those at least of asphyxia from chloroform in childhood, the most natural and simple method is also the best, viz. by manipulation of the ribs, which is best done in the position recommended by Dr. Howard.¹

It does not appear that there are any limitations to the use of anæsthetics in childhood. I have administered them at the earliest periods of life, and believe that, with proper care, operations are safer with them than without them, even in the most exhausted and puny infants. In harelip and other operations about the mouth which do not last a long time I rarely administer chloroform, although I have no strong objection to doing so; but in all other painful proceedings the general rule should be to give it. One motive, however, for the use of anæsthetics is absent in children, since they have little apprehension of the operation, and thus do not suffer from those agonies of anticipation which are often the worst part of a surgical operation to an adult.

As soon as the child has recovered consciousness, the smarting of the wound, and the remembrance of his fright, make him cry violently; and then, unless vomiting seems probable, it is well to give a few drops of laudanum, proportioning the dose to the child's age. But in other cases the operation is succeeded by a quiet sleep. Vomiting, which is very common with children, even if they have had no food for some time, usually subsides before consciousness is completely restored, and is very seldom troublesome.

Serious operations in children are almost always followed by smart fever. This is, however, usually transitory, and subsides with the commencement of suppuration, and it may be much diminished by irrigating the wound with water dropped out of a bottle by means of a lamp-wick, or the application of ice, as recommended by Professor Esmarch, or of Leiter's tubes. The greater probability of union by first intention in children makes it justifiable to close wounds which would be left to granulate in the case of an adult patient; but any dressing which is likely to prove painful, whether in application, in use, or in removal, ought to be avoided as much as possible.

MALFORMATIONS.

Table of Malformations.

Of the whole body, or general. Double monsters: attached foetal remains.

Of the head and face. 1. Of the mouth: congenital fissure; harelip; fissured palate.²
congenital closure or atresia oris; microstoma congenitum.

2. Of the nose: congenital absence.

3. Of the eye: ³ " fissure.
" defects of iris.
" cataract.
" closure of the lids.

4. Of the head: ⁴ cephalæmatoma, congenital tumours; meningocoele and encephalocele.

Of the spine. Spina bifida; congenital tumours.

¹ *Brit. Med. Journ.* June 18, 25, 1881.

² Treated of above, see the essays on DISEASES OF THE MOUTH and on PLASTIC SURGERY.

³ Treated of in the essay on DISEASES OF THE EYE, vol. ii.

⁴ Treated of in the essay on REGIONAL SURGERY.

- Of the neck. Congenital closure of œsophagus; congenital stricture.¹
 Of the thorax. „ fissure of the bones; malformation of heart.¹
 Of the abdomen, &c. Congenital defect of parietes;¹ malformation of viscera;¹ imperforate rectum; congenital hernia;² undescended and retained testis.³
 Congenital adhesion and imperforation of vagina.⁴
 Hypo- and epi-spadias; extroversion of the bladder.⁵ Hermaphroditism. Congenital defects of the pelvis.¹ Imperforation of the urethra.
 Of the limbs. Deficiency of bones and limbs;¹ supernumerary fingers and toes; webbed fingers and toes; congenital dislocations; fracture and amputation in utero.

ATTACHED FŒTUS.—In very rare instances twins become attached in the womb, and are born thus into the world; and this in two different conditions, viz. either as two living individuals united at some part of their bodies; or one fœtus is only imperfectly developed, and in this imperfect condition is attached to the other as a parasite.

Of the first condition the Siamese twins, the Hungarian sisters, and the pair of black girls recently exhibited in London, are the best-known examples. The only purely surgical question which occurs with reference to the treatment of such cases of monstrosity is as to the expediency of dividing the connecting ligament, and setting them free from what is not merely a restraint but also a grave danger, since the death of one twin must necessarily involve that of the other. In a work like the present it would be absurd to waste space upon such curiosities of surgical practice, in the treatment of which the surgeon would be bound to have recourse to the authorities specially devoted to the subject.⁶ It may, however, be stated in general terms that when important parts (such as the anus) are common to the twins, the operation is impossible; that when the connection is in or near the buttock, a communication may fairly be supposed to exist between the spinal columns, which would render any operation fatal; but that when the connection is sideways, and the band of moderate thickness and extent, the operation ought to be attempted, and has been performed with success;⁷ also that if one twin die before the other, an attempt might be made to cut the dead one away.

The second class of joined twins—viz. that in which one of the twins is only slightly developed, and included in the living twin as a parasitic growth—is of considerably more importance in surgery than the former, since both the diagnosis and the treatment become occasionally matters of considerable doubt and difficulty. I shall consider these cases under the natural division of attached parasites and included parasites; but we must not forget that this division, however natural, is not to be trusted in practice, since a great part of the attached parasite may be included. However, the difference is so striking between those cases in which large parts of the parasitic fœtus (usually terminating in more or less rudimentary extremities) hang pendulous from the principal organism, and those in which the parasitic remains form a mere tumour which may not even be prominent under the skin, that the distinction will always be made.

No difficulty of diagnosis can exist in the case of the attached parasite. The advantages and the feasibility of removing it from the body to which it is appended will depend in a great measure upon the place and extent of its attachment, and partly upon the nature of the parasite itself. If a large part of the imperfect twin is attached in the near neighbourhood of vital organs, as in the case of the Asiatic, whose cast is in so many museums, having a large part of the body and both extremities of another fœtus hanging from his thorax, much care would be required in attempting the removal of the parasitic growth. Still there would, I should suppose, be no insuperable difficulty in amputating at any rate so much of it as

¹ Nothing is said about these malformations here, since they do not admit of surgical treatment.

² See the essay on HERNIA.

³ See the essay on DISEASES OF THE MALE ORGANS.

⁴ See the essay on DISEASES OF WOMEN.

⁵ See the essay on DISEASES OF THE URINARY ORGANS.

⁶ Amongst which may be specially mentioned Dr. W. Braune's work entitled *Die Doppelbildungen und angeborenen Geschwülste der Kreuzbeinegend*, where all the known cases of twins attached in the sacral region are given, up to the date of the work.

⁷ The case in which adhering twins were successfully separated is related by König in the *Ephem. Germanicæ* (nat. cur.), 1690, vol. viii. dec. ii. obs. 145.

A drawing is given of them united by a band, which is described as stretching from the ensiform cartilage to the umbilicus, and as being an inch broad, one and a half inches deep, and five inches long. The umbilical cord was single, and contained four arteries and two veins. Its lower part was attached to the band, and it seems doubtful whether the band was really anything more than a fusion of the two cords. A ligature was put upon it first, and then it was divided with a knife. The separation, he says, was effected 'ligaturâ prægressâ indies strictiori, dein cultelli scissurâ.' Mr. Startin proposed a similar plan for the separation of the Siamese twins, by surrounding the connecting band with a metallic girdle, formed of two parts sliding on each other, and hooped together by pegs or notches. One of these notches being drawn in every day the girdle would be imperceptibly tightened, till merely a thin band of skin would remain, which could be severed without any risk (*Brit. Med. Journal*, Feb. 20, 1869). An examination of the uniting band and of the abdominal viscera of these twins was made after their death, and will be found described in the *Trans. of the Coll. of Physicians of Philadelphia*, 1875. The two livers were in such close contiguity in the band, and the two portal circulations had so free an anastomosis, that in the opinion of Dr. Pancoast no operation for their separation could have been successfully performed in adult life, though he believed that it might possibly have been successful in infancy, and that 'it would have been the part of wisdom and humanity to make the effort.' He also thought that after the death of the first twin, his body might have been separated from the other by dividing the band close to the dead body.

would restore the person to a natural appearance when clothed. A clamp might be fixed tightly on the neck of the tumour, or large vessels might be discovered and tied before the operation, or the pedicle might be severed by gradual strokes of the knife and the vessels tied as they were divided, or finally the question of piecemeal amputation at several sittings might be entertained.¹

The removal of such parasites when they occupy (as they far more often do) the pelvic region is very necessary to the patient's comfort; but here, before their removal is decided on, the question of their nature and connections must be very carefully considered. In those cases of double monsters (like the Hungarian sisters) where the twins are attached by a broad band near the buttocks, it has always been found that either the rectum, genitals, or lower end of the spinal column, or all these parts, were common to both bodies; and therefore that the twins could not be separated without fatal consequences. But when the deformity is that which is commonly called 'the human tripod,' in which the two legs of another foetus, blended together into one, are attached to the pelvis, no such connection is probable. The genitals of the parasitic foetus as well as the spinal column are probably absent; and if they were developed, it would still be possible in many cases to remove the projecting extremities. In cases of tripodism, therefore, amputation should be practised, especially on males, in whom the defect could only be concealed from view by condemning them to wear female clothing. All the published cases of this deformity will be found collected in the work of Braune, '*Die Doppelbildungen*,' &c. I would especially call attention to the case (mentioned in that work on p. 20) of Anna M. Przesomyl, a Bohemian. She was shown, at six years of age, to the *Gesellsch. d. Naturforscher* in Prague, and had then an irregular oval swelling, covered by the normal skin, hanging from the buttock by a pedicle, so that it struck against the legs when she walked. The skin was healthy, except over the pedicle, where it was thin, and almost like mucous membrane. Bodies resembling long bones could be felt in the tumour, and there were 'evident traces' of fingers or toes projecting from its lower part. Foetus in foetu was universally diagnosed. As no evidence could be obtained of the extent of the tumour inside, or of the nature of the connection with the pelvic organs or spine, the operation was declined. The child was then taken about as a show, and seen by all the anatomists and surgeons of Germany, Holland, Sweden, and Denmark. Dieffenbach proposed to remove the parasitic growth; but the father would not consent on account of the gain which he made by showing the child. The parasite grew; but her health continued quite good. At sixteen she determined to have it removed (although she could walk quite upright, and had perfect health), so much did she suffer from the weight of the parasite. Its shape, size, &c. are shown in an engraving in Braune's work. The length was about 26 inches; the weight was guessed at about 20 pounds; the pedicle, which passed into a kind of niche in the buttock, was about as thick as the forearm.² It was successfully amputated through its first swollen portion, leaving a considerable stump; but this stump, which would never heal, was accidentally attacked with gangrene in consequence of a fall, and was then successfully removed by ligature and sawing through its bony connections. In the end the girl seems to have been quite cured.³

I need not dwell here on the cases of included parasites (i.e. foetal remains forming a tumour, either subcutaneous or in one of the great cavities or viscera), since such cases must be treated on the same rules as any other innocent tumour.

CONGENITAL SACRAL TUMOURS.—In connection with these cases of included foetus and attached foetus we must also speak of those rare cases in which congenital tumours are found in the sacral region, which have no distinct marks of parasitic origin. Such are the cystic, fibroid, and fatty congenital tumours.

These tumours it is important on many grounds to distinguish from the included and attached parasites. They are divided by Braune into three categories: 1. coccygeal tumours, which are compound cystic, and other congenital and more or less solid tumours of this region; 2. simple cysts; 3. caudal excrescences and lipomata. The first class are of various compositions, and grow more or less rapidly. They are intimately connected to the sacrum and to the coccyx, when that bone is developed; and they very frequently are in connection with the spinal membranes. When the spinal canal, however, is closed, they usually spring from the interior of the pelvis, and press the coccyx backwards. The anus is displaced forwards, and the growth is, according to Braune, always limited by the edge of the *gluteus maximus* muscle. Operative interference with such tumours is in the highest

¹ I have been informed by Dr. Pancoast, jun., of Philadelphia, of a case in which his father successfully removed with the *écraseur* an attached parasite from the facial region. The photographs of the child before and after operation are in the Museum of St. Bartholomew's Hospital. This operation seems to have been done in early infancy; and it would probably be in most cases advisable to make the attempt as soon as possible. More than ordinary complications in the operation, or unusual weakness of the infant, might induce the surgeon to wait for a time. The photographs referred to show that the parasitic foetus was attached to one cheek of the living child, that the body was provided with rudimentary extremities, and ended in a large fibro-fatty mass; and that on cutting it open many of the parts of the natural body could be distinctly traced in it, especially the gastro-intestinal tract. The only harm that was occasioned by its removal appears to have been that a fistula into the mouth of the infant was left in consequence of the buccinator muscle having been prolonged into the coverings of the parasitic foetus, and having been injured in its removal. The case occurred many years ago; but I believe was never published in *extenso*.

² *Prag. Vierteljahrsschrift*, 1850, vol. xxv. p. 74.

³ Other instances of the successful removal of these superfluous limbs will be found in my work on the *Surgical Treatment of Children's Diseases*, 2nd edition, pp. 11, 12.

degree dangerous, and should by all means be avoided if possible,¹ though the occurrence of convulsions or other symptoms dangerous to life may induce the surgeon in rare instances to interfere. Such was the case in the only tumour of this kind which I have myself seen. It was in appearance a simple fatty tumour, but was connected with the interior of the spinal canal, and had caused convulsions. It was extirpated with success by Mr. Athol Johnstone, whom I assisted in the operation. We both saw distinctly the bulging and pulsation of the spinal membranes after the removal of the tumour. The child died of another disease some months afterwards; and the nature of the tumour was proved by dissection.²

The other descriptions of congenital sacral tumour, viz. the cystic and the caudal or lipomatous, are apparently somewhat less dangerous, especially the former, although none of these tumours can be operated on without risk.

The main points in the consideration of these rare affections are to distinguish if possible between the congenital tumour and the parasite, and to determine in the case of either of them whether there is any connection with the interior of the spinal canal or with the pelvic viscera. The distinction between the parasites which do not show characteristic shapes (as those do, for instance, which terminate in fingers and toes) and the tumours is by no means easy. Even after removal from the body, it is not always possible to be confident as to those which contain a number of cysts mixed with various tissues, such as shapeless masses of cartilage and bone, whether these tissues are parts of an undeveloped foetus or mere accidental formations.³

In my work on the 'Surgical Treatment of Children's Diseases' (p. 14) is the account of a very large congenital tumour, of the compound cystic variety, projecting in the left buttock, and attached near the coccyx, which I removed successfully from a female child, three years of age. The tumour was so intimately connected with the lower bowel that it had an impulse on coughing just like a hernia. The large cyst contained fluid, resembling cream in colour, but very fetid. At its base were some smaller cysts, but no distinct traces of any foetal structure. A somewhat similar case, under the care of M. Stoltz of Strasburg, appears to have been of the dermoid variety.⁴ Numerous other instances of the successful extirpation of these congenital sacral tumours have been put on record.

In congenital sacral tumour, whether from foetal inclusion or not, the question of surgical interference depends not on the origin but on the connections of the tumour: there are foetal tumours which may be removed with perfect success, while there are other tumours, not foetal, in which the formation may be so far within the pelvis as to be inaccessible to the knife. Another point is, I think, equally clear from the records of the treatment of such cases, viz. that the total removal of the tumour is a safer course, if surgical interference is admissible at all, than any partial operation.

In fact, it is difficult to see what useful purpose is to be served by these partial proceedings. Either the tumour is within reach of dissection, or it is not. If it be, and if the operation be undertaken in childhood, and the operator succeed in removing the tumour entire, there is hardly an instance on record in which the operation failed of success in uncomplicated cases. But suppose, on the other hand, that the tumour passes so deeply into the pelvis as to be beyond the reach of the knife; what prospect is there then that even a child, far less an adult, could survive the diffuse cellular inflammation, the consequent abscess in contact with the pelvic peritonæum, and the possible visceral complications which would follow from laying open such a cyst with a view to its obliteration by granulations, or from passing a seton through it, or from injecting it with an irritating fluid? I think it undeniable that in any doubtful case the more prudent course would be to endeavour to remove the tumour; and if this turns out to be impossible, then as a *pis-aller* to remove as much of it as possible, and leave the remaining cavity to granulate up. I speak of it as a cavity because these tumours are generally more or less cystic; and I should suppose that the prolongation of a solid tumour deep into the body could be ascertained before operation.

The question, then, resolves itself into discovering the connections of the tumour as far as possible—whether it communicates with the spinal canal, with the rectum or bladder, or passes up so far into the pelvis as to be inaccessible. The diagnosis must be allowed to be sometimes very difficult. If the tumour, as in my case, be situated quite to one side of the middle line, the idea of its spinal origin may be laid aside; but in all doubtful cases the nature of the fluid contained in the sac should be very carefully ascertained by puncture and subsequent chemical analysis. The communication with the spinal canal is often so small as to escape detection by physical examination; so that if a tumour lying in or near the middle line contains fluid resembling that of spina bifida, it must be regarded as of spinal origin; and no attempt should be made to extirpate it, unless it seems absolutely necessary in order to preserve life.

The communication of a tumour of this kind with the rectum can be judged of by the

¹ Braune gives reference to 46 cases, in 16 of which operative measures were attempted; but in only 5 with success. In all 5 extirpation was the method adopted, which is much preferable to ligature or puncture. The subdivisions which Dr. Braune makes of this class of tumours are not necessary for our purpose.

² *Path. Soc. Trans.* vol. viii. pp. 16-28.

³ This remark is illustrated by a preparation in St. George's Hospital Museum, consisting of a number of irregular pieces of bone from a congenital tumour removed by Sir B. Brodie from the sacral region. The operation proved fatal.

⁴ See the French translation by Dr. Larcher of my work on the *Surgical Treatment of Children's Diseases*, p. 17.

occasional discharge of its contents in the motions. Whether this fact precludes the possibility of successful removal is a question for the surgeon carefully to weigh. It is, to say the least, an obstacle to operation. Communication with the other pelvic viscera, as the bladder or vagina, is no doubt possible; but I do not know of an instance.

The depth to which the tumour extends in the pelvis can only be imperfectly determined before operation. On the one hand, my case shows that even a very distinct impulse may be present without the tumour being in contact with the abdominal portion of the intestines, or penetrating into the general peritoneal cavity; while a case reported by Senfleben,¹ on the other, proves that the peritoneum may be opened in operating on a case where no such impulse has been noted, though it proves at the same time that such an accident is not necessarily fatal.

In the 'Brit. Med. Journ.,' March 23, 1867, I collected the results of all the cases of congenital sacral tumour, which are reported by Braune, where operations were practised, with the addition of Corradi's,² Senfleben's, and Jollye's³ cases, which were published since the date of Braune's work, and all of which were successful.

The following are the main results: 1. As to congenital tumours not of a foetal nature, including all forms of tumour, both solid and cystic, extirpation was carried out in nineteen cases reported by Braune, though in some of them it seems not to have been complete.

Four of these tumours communicated with the spinal canal. In the two cases where the surgeon was able to remove the whole tumour the operation succeeded; the tumour being in both cases fatty. In the two other cases the tumour (more or less cystic) was only partially removed, and death followed.

In five cases, where the tumour was pendulous and more or less solid ('caudal lipomata,' Braune), extirpation was complete, and successful in all.

This leaves ten cases of tumours, chiefly cystic, unconnected with the spinal canal, and attached to the sacrum or coccyx. Extirpation was only partial in two cases; in one of which the result was fatal, in the other doubtful. In the other eight cases the removal seems to have been complete, and all the patients recovered except one. To these Mr. Jollye's case is to be added.

The other methods of treatment, less radical and in appearance less formidable, show nevertheless a result in striking contrast to the great success of removal. Under the head of simple 'incision,' or 'puncture,' are contained the records of four cases of 'coccygeal tumour,' and five of 'sacral hygromata.' All were fatal. But in another case of sacral hygroma, puncture followed by iodine injection was effectual in curing the disease. The ligature was used in three cases of 'coccygeal tumour,' and in two cases of sacral hygroma; the two latter cases were cured, the three former were all fatal; but it is fair to note that in two of them it seems as if the complete extirpation of the tumour was contemplated, but was found impossible, owing to its extensive connections, the disease being of a malignant nature. Here the ligature seems to have been employed only as a last resource, probably to save the patient from bleeding to death.

The inference from this is inevitable, that in all those cases of congenital sacral or coccygeal tumour in which it appears desirable to interfere at all, the complete removal of the tumour, either by the knife or the ligature, should be the aim of the surgeon, and that it is in reality far more safe to dissect-out the tumour than to pass a ligature beneath it. In a case where the tumour spreads so far into the pelvis that it cannot be followed with the knife, the ligature perhaps must be used, but it can hardly succeed in curing or even checking the progress of the disease. Punctures (except for purposes of exploration), incisions, and setons, ought to be absolutely rejected; nor would I advocate the employment of iodine injection in any case that seemed at all suitable for removal.

2. Next with reference to tumours of foetal origin. After laying down the natural division of these foetal tumours into 'supernumerary limbs' and 'parasite-tumours,' and calling attention to the insufficiency of minor operations, Dr. Braune says: 'Either amputation or extirpation, whether with the knife, ligature, or éraseur, must always be the operation undertaken. In case of supernumerary limbs, flaps are formed, and the proceeding more resembles an amputation, while in the parasite-tumours it is more of the character of extirpation. Where the tumour is pedunculated, pendulous, or with a bony attachment and very vascular, the éraseur may be used with advantage, or Middeldorp's galvanocautic, which more than replaces the old ligature and annular application of the cautery.'⁴

'Incision into the fluctuating swelling was practised twice, and was followed in both cases by death. In one, injury of the spinal membranes was the cause, the tumour being of the nature of spina bifida.

'The bony stalk was sawn through, and its upper part left in the pelvis in three cases, and in all with success.

'Extirpation was practised eleven times; ten times with success, in the other with a fatal result, spina bifida being also present.

'The ligature was used three times; twice successfully, once it had to be taken off again on account of convulsions.'

¹ *Deutsche Klinik*, 1865, p. 174.

² *Ann. univer. di Med.* for 1866, vol. xciv. p. 423.

³ *Lancet*, Aug. 4, 1866.

⁴ Some of the forms of thermo-cautery, or electric cautery more recently introduced, would now be used in place of Middeldorp's very efficient, but exceedingly cumbrous and expensive, apparatus.

The three amputations referred to above were—1. By Pitha, quoted above, p. 780. 2. By Geller ('Virchow's Arch.' vi. 520), of a tumour terminating in a finger and of very large size, which was removed at the age of eight weeks. 3. By Schuh ('Wien. Med. Wochensh.' 1855, No. 51), of a large tumour containing portions of intestine, nerves, and numerous pieces of bone, and attached to the sacrum by a bony pedicle.

To these instances of amputation of supernumerary limbs I may add Dr. Corradi's case, in the 'Annali Universali' for 1866.

The successful cases of extirpation of a sacral tumour with foetal remains belong to the following surgeons: Jacob of Dublin, Otto, Middeldorpf, T. Blizard, Schwartz, Langier, Porta, Lotzbeck, Emmerich, and Oslander. For the references, I must refer to Dr. Braune's work.

To these instances of successful extirpation, Senftleben's case, above quoted, is to be added; making the number of successful operations eleven, against one failure.

The total result of this series of operations would be, that we have two instances of successful amputation of well-marked and large-sized supernumerary limbs, two of amputation of tumours of foetal character and attached to the pelvis by a stalk, and twelve of extirpation of tumours of a foetal nature apparently not so attached, and that in all the cases, except one of the last-named, the operation succeeded; while in the fatal case the disease was complicated with spina bifida.

I think, then, that the evidence which I have here produced (and which includes, though perhaps not the whole, certainly the great bulk of the cases published up to that date) is very favourable to operative interference in these distressing deformities. The results of experience also confirm the conclusions of *à priori* reasoning, in showing that when operative measures are necessary, total removal is the proceeding that should be adopted. In the great majority of cases I think that the knife will be found safer than the *écraseur*, and *à fortiori* than the ligature.

It appears more prudent, both in cases of subcutaneous parasitic formations and in compound tumours, not to be too anxious to extirpate the entire growth. If the projecting portion which is interfering with the patient's comfort be removed, that is all that may be necessary. A too-deep dissection may easily produce fatal mischief. It does not seem that supernumerary limbs, if amputated, ever grow from their base; and in the case of tumours, though they may certainly grow again, the risk of having to perform a second operation seems to be, on the whole, the less evil of the two. The simple cyst must, however, of course be extirpated entire, if at all.¹

CONGENITAL MALFORMATIONS OF THE FACE are not limited to harelip and fissured palate exclusively, although those malformations form so much the larger part of the whole, that a man may have had an extensive experience in the treatment of them without ever having had an opportunity of seeing the rarer forms.

A condition of the mouth is spoken of similar to that which so often affects the anus, viz. congenital imperforation—*atresia oris*. It does not seem, however, that any instance is related as having occurred within modern times. The treatment would consist in removing the membrane which closed the mouth, and attempting to unite the skin to the mucous membrane around the opening, so as to promote union by the first intention, without which a recurrence of contraction would be probable.

The congenital smallness of the mouth (*microstoma congenitum*) spoken of by Von Ammon and Dieffenbach² appears to be merely a phenomenon of deficiency in the development of the lower jaw, and therefore to be beyond treatment.

A fissure similar to the common harelip is said³ to have been occasionally noticed in the lower lip; and another similar deformity is that which extends laterally from the angle of the mouth, so as to expose the back teeth (*macrostoma congenitum*⁴).

Fissures into the nostril through the substance of the cheek are also met with in a few instances.

All such deformities must be treated on the same general principles of plastic surgery which guide us in operations for harelip; viz. to close the opening by drawing over it the soft parts with their raw edges in as neat apposition as possible, and with as little tension as may be. Any adhesions to the bones of the face which render this difficult must be divided. If the cleft be very large, it may be necessary to cut free a flap to glide over and fill it; and in all cases in which the muscles tend to drag on the wound, their action should be neutralised by the 'harelip suture.'

Congenital absence of the nose has been spoken of, the feature being replaced by two mere openings on the surface of the face; and an operation has been described, which is said

¹ I have not thought it necessary to add to the foregoing summary, written more than ten years ago, the result of subsequent experience. I need only add that the great diminution in the mortality of cutting operations of late years would be an encouragement to greater boldness in removing these formidable tumours.

² Fritze u. Reich, *Plastische Chir.* p. 90.

³ Nélaton, *Path. chir.* vol. ii. p. 699.

⁴ Von Ammon, *Angeborne Chir. Krankh.* tab. iv. p. 14: Debout, *Bull. de Thér.* vol. lxiii. p. 15. Sir W. Fergusson, in his lectures at the Royal College of Surgeons, exhibited drawings of each of these malformations (*Lancet*, June 25, 1864); and drawings of all these malformations of the face have been inserted by Dr. Larcher in his translation of my work on the *Surgical Treatment of Children's Diseases*. (See above fig. 146, p. 675.) Mr J. H. Morgan lately reported to the Royal Med. and Chir. Soc. (Nov. 8, 1881) two cases of congenital macrostoma, accompanied by malformation of the auricles and by the presence of auricular appendages (*Med.-Chir. Trans.* vol. lxxv.)

to have cured this horrible deformity.¹ It is not, however, very clearly described, nor does the case seem to have been satisfactorily followed up. It is difficult to understand how a prominent feature could be fashioned out of the soft parts, if the nasal bones were wholly absent. In such a case Langenbeck's operation for transplanting the periosteum of the frontal bone might possibly be of service.

The congenital defects of the organs of vision have been spoken of in vol. ii.

The malformations of the brain and its coverings, which give rise to the tumours of the skull named meningocele and encephalocele, will be found described with the other tumours of the same region in the essay on REGIONAL SURGERY.

SPINA BIFIDA.—This is the next congenital affection which should engage our attention. It is a malformation which is seen, perhaps, more frequently than any other except harelip. It may be defined as a congenital hernia of the spinal membranes through a fissure in the walls of the canal. Thus a tumour is formed, which is usually of a rounded shape, lying in the middle line of the back, fluctuating, often semi-transparent, adhering to the bones of the column either directly or by means of a pedicle.

Anatomy.—I shall not attempt in this place to describe the anatomy of the rarer forms of spina bifida, some of which, such as complete fissure of the whole spine, are incompatible with life, and therefore of no surgical interest; while others, such as the multilocular tumours, those which are complicated with complete absence of vertebræ, those which arise from fissure of the body instead of the laminæ, &c., are so rarely met with that each case would require a separate description. Excluding these rarer forms, I shall describe the surgical anatomy of spina bifida, in the same manner as that of other herniæ, viz. (1) the coverings, (2) the sac and its neck, (3) the contents.

1. The tumour is in most cases covered by healthy and unaltered skin; frequently, however, the skin is variously modified from the standard of health. Cases are recorded in which the density of the skin was increased, so that it is described as hard and coriaceous;² but it is far more common to find the skin thinned or even altogether deficient. This is due to one of two causes: either the skin was originally properly formed, with the cutis and epidermis natural, but has become thinned as the tumour increased; or the skin has been congenitally deficient, being represented only by a thin fibrous material (something like a cicatrix) covering the spinal membranes, or even altogether absent, so that a bluish-red membrane permeated by vessels is exposed, which is the spinal dura mater. In some of these cases it is said that the latter membrane also has been absent, and the arachnoid exposed. When the coverings of the tumour are thin, serum may ooze through them without any actual hole;³ but ulceration very soon takes place as the tumour increases, and then the sac bursts.

2. The sac of a spina bifida is formed of the membranes of the cord matted together; and, in some rare cases where extensive malformation is connected with hydrocephalus, this sac is lined by the substance of the cord itself, spread out into a thin layer on the inside of the membranes. Its neck is formed by an opening in the laminæ and spinous processes of one or more vertebræ, and is longer or shorter according to circumstances. When the hole in the canal is large and the tumour sessile, there seems to be no neck; while at other times the tumour hangs down over the child's back by a long stalk, which in one case is said to have been a foot in length.⁴

3. The contents of the sac are, *first*, in all cases more or less watery fluid—the sub-arachnoid fluid; *second*, in most instances a portion of the cord itself, or the cauda equina, or some of the spinal nerves; and *lastly*, in very rare cases more or less of connective tissue, or of fat. Spina bifida is caused either by an arrest of development in the arches, or by a dropsy, probably inflammatory, of the membranes before the bones are ossified. Either cause would account for the fact that the malformation is far more common in the lumbo-sacral region than in all other parts of the spine put together. There are too few preparations of spina bifida in the higher parts of the column preserved, or accurately described, to allow of an opinion as to their usual contents; but it is known that in the common position of spina bifida, the cord, or some important part of it, is almost always contained in the sac.⁵ When the cord itself, or its prolongation, is the part contained, it is always closely united to the back of the sac in the middle line. The nerves either run across the cavity of the sac, or in the substance of its tissues, to their destination.

Symptoms.—The symptoms of spina bifida will be easily understood when its anatomy is known. The tumour is always in the middle line, and always attached to the bones. The hole in the canal can be readily felt if the parts which cover it are not very thick. If the skin is thin, the tumour has the transparency of hydrocele. The fluid can often be partly pressed back into the canal, and then tension of the fontanelle, or increase in the size of the hydrocephalus (if the latter exists), will be noticed; nervous symptoms also are frequently produced. The size or tension of the tumour is sometimes increased when the child cries. Symptoms due to interference with the functions of the cord are not infrequent—palsy of the limbs or of the sphincters, and convulsions.

¹ Maisonneuve, in *Bull. de Thér.* 1855, vol. xlix. p. 559.

² Case iv. in Mr. Prescott Hewett's paper, *Med. Gaz.* vol. xxxiv. p. 460.

³ Laborie, *Ann. de Chir.* vol. xiv. p. 272.

⁴ *Boston Med. and Surg. Journ.* 1862, p. 456.

⁵ Mr. Hewett found only one such preparation out of twenty in which the nerves were not connected with the sac, *op. cit.* p. 461. The cord has been found in the sac in the dorsal region, Laborie, *op. cit.* p. 280.

The progress of the disease is usually to death. As the size of the tumour increases, the patient often dies of convulsions, or the skin ulcerates and the tumour bursts; and then palsy or convulsions produce death. But although the great majority of cases are speedily fatal, it is not always so. Many cases are recorded in which the tumour has continued to grow, but not more than in proportion to the rest of the body, and has produced no symptoms—the patient dying at various periods of some other disease.¹ In other and much rarer cases, the disease has undergone a process of spontaneous cure; the elongation of the pedicle produced by the weight of the tumour having resulted in closure of the orifice of communication with the spinal canal, so that there remained merely a closed cyst, which either remained innocuous or was removed. Finally, recovery has been known to follow on the rupture of the sac.

Treatment.—In former times little could be said as to the treatment of cases of spina bifida. A few scattered cases of cure were no doubt on record. Thus the disease has been cured by repeated tapping combined with the application of pressure to the tumour,² but everyone who has tried the plan agrees that such successes are very rare exceptions. Again, the tumour has been removed entire, the pedicle being united by sutures, or a clamp has been applied to the pedicle, and when it has been thus proved that the cord or large nerves are not contained in the sac, the latter has been removed. Dr. Wilson, of Claycross,³ Signor Rizzoli,⁴ and Signor Berardi may be named as having operated successfully in this manner. But the operation is only applicable to those very rare cases in which the tumour contains neither the cord nor the large nerves, and is chiefly, though not solely, used in pedunculated tumours. Now, the great majority of the ordinary cases of spina bifida, occurring at the lower part of the spine, have no pedicle, and in all probability contain either the cord or the cauda equina. Hence few cases of excision are recorded, and most operations of the kind prove fatal even when there are no great nerves in the sac.⁵

I do not speak of other methods of treatment which are still more dangerous and are now abandoned, for happily the injection of the tumour by the iodo-glycerine fluid has proved so successful in the hands of Dr. James Morton⁶ and his pupils, that all curable cases of spinal bifida are now treated in this way, and I believe with a large percentage of success. The plan is very simple. It is well to examine the tumour in a dark room by transmitted light, in order, if possible, to discover and avoid any large nerves. Then the sac is punctured with a small trocar⁷ away from the middle line, any large vein being of course avoided, and about half the fluid in the sac is evacuated. Then a syringe filled with the following solution is adapted to the trocar: iodine, ten grains, and pot. iod. thirty grains, in an ounce of glycerine. The quantity of the injection will be proportioned to the size of the tumour. About half a drachm may be taken as an average. It is of the greatest importance to prevent any access of air into the sac, and any subsequent escape of the cerebro-spinal fluid. As the trocar is being withdrawn the lips of the little wound should be grasped, and thoroughly painted with collodion. Then a square piece of lint soaked in collodion is to be applied over the wound, and carefully bandaged on. Oozing of the cerebro-spinal fluid seems a much greater danger than inflammation of the sac or spinal membranes from the injection. If all goes well and the tumour does not increase, the case should be left to itself for a considerable time. If it is growing it is necessary to repeat the injection, or if, after waiting long, it does not shrivel. When the cure is complete, only some shrivelled remains of the sac adherent to the hole in the laminae show what the affection has been.

Dr. Morton published in his book a condensed account of fifteen cases. Of these twelve had been entirely cured; three had died, but in one (Dr. Watt's third case) from causes quite unconnected with the operation. The second was a doubtful case in the upper cervical region, very probably an encephalocele; and the third was a hopeless case, in which the tumour had ulcerated and burst, and the child was paralysed before the operation. Since that time Dr. Morton's experience has been of precisely the same nature. In a letter dated July 4, 1881, he tells me that he knows now of thirty-two cases in all, treated strictly on his method.⁸

¹ The most advanced age, to which any patient has been known to survive, seems to be fifty: v. Behrend in *Journ. f. Kinderkht.*, vol. xxxi. p. 350. A curious case is recorded, in the *Bull. de la Soc. de Chir.*, 1860, p. 396, of a man who lived to the age of forty three, having survived a very complicated operation for the stone, and died of a recurrence of the latter disease.

² Sir A. Cooper relates in the *Med.-Chir. Trans.* vol. ii. p. 324, two cases cured by this plan, and one in which the disease remained stationary under the influence of pressure only. Behrend (*Journ. f. Kinderkht.*, vol. xxxi.) gives a successful case of puncture and pressure, and one in the practice of Mr. Image of Bury, is related in *Bryant's Surgery*.

³ *Path. Trans.* xiv. 214. ⁴ *Memorie chir. ed ostet.* vol. ii. p. 565, where Berardi's case is also related.

⁵ I have removed spina bifida tumours with the knife in two cases, and both proved fatal. The first is recorded in my book on the *Surgical Treatment of Children's Diseases*, 2nd. ed. p. 88. Death occurred from meningitis. The other was a very singular case of a congenital multilocular pedunculated tumour, of the nature of which I felt uncertain, but which was increasing rapidly, and seemed unfit for iodine injection. It was excised under the carbolic acid spray, and the wound dressed with carbolic acid. It proved to communicate with the spinal canal, and the discharge of the cerebro-spinal fluid on section of the pedicle was followed by considerable collapse, from which, however, the child rallied. Next day carbolic acid showed itself in the urine. The child was very restless, but had no convulsions. In the night it suddenly expired.

⁶ See *The Treatment of Spina Bifida by a New Method*, by Dr. J. Morton, Glasgow, 1877.

⁷ The trocar must not be too small, or the thick fluid cannot be injected through it.

⁸ As Dr. Morton justly remarks, the subsequent closure of the puncture and accurate prevention of the leakage of the cerebro-spinal fluid is an essential part of the method. The mere injection of the iodo-glycerine fluid, if followed by leakage of the contents of the sac, is pretty sure to prove fatal.

Of these, twenty-six have been successful, and of the six which died three were hopeless from the first, and should not have been operated on. Other surgeons, however, have been less successful. See the report of a discussion at a recent meeting of the Clinical Society, in the 'Brit. Med. Journ.,' Nov. 18, 1882.

It is evident that such a series of cases as this quite changes the surgical aspect of this affection, and the advice which ought to be given to parents. In common with other authors who have written on this subject, and who have had considerable personal experience in its treatment, I have dissuaded active treatment except in a few cases, and have then recommended the injection of watery solutions of iodine and iodide of potassium; but now I have no doubt of the duty of surgeons to test Dr. Morton's plan thoroughly, and to apply it to all cases of spina bifida in which there are not special contra-indications, such contra-indications being great feebleness of the infant, other concomitant deformities rendering sound cure impossible or highly improbable, and complications in the tumour itself, such as its ulceration or inflammation, causing softening of the cord and paralysis, or unusual size of the deficiency in the bones. If in any such case the surgeon chooses to yield to the wishes of the parents and try the effect of operation, he is not perhaps to be blamed; but it should be distinctly explained to them that there is little hope of benefit from any treatment.

My own personal experience of the plan is at present limited to a single case, and that was so peculiar in the position and structure of the tumour that I cannot be quite sure of its nature. A healthy infant had a congenital bilocular tumour, containing clear serum, and apparently connected by a very small pedicle to the lowest part of the spinal column at or near the tip of the coccyx. It seemed connected to the spinal column; but whether its interior communicated with the spinal canal was doubtful. I injected the larger cyst with about 5ss. of Morton's fluid. No symptoms followed: the puncture burst some days afterwards and the cyst shrivelled up, leaving the smaller cyst, which seemed quite unconnected with the larger one, in its original condition. The child was discharged from the hospital, but some weeks afterwards was brought back with the smaller cyst evidently suppurating, the shrivelled remains of the larger cyst being quite quiet. An incision was made into the suppurating cyst and it also shrivelled away without any bad symptoms, leaving the child quite well.

False spina bifida.—This term includes several perfectly different forms of superficial tumour, all of which agree in this leading feature, that they communicate with the cavity of the spinal canal, but not with that of the membranes. They are, 1. True spina-bifida sacs, the necks of which have become obliterated, and which have thus become detached from the membranes. 2. Congenital tumours. 3. Included fetal remains. Like the true spina bifida, these are more common in the lower part of the column.

1. Pedunculated sacs, which communicate with the spinal theca by a narrow channel, may have that channel closed, either by inflammation occasioned by the dragging of the tumour and the pressure of the parts around, or by the growth of the bones encroaching on the membranous tube. Such is believed to have been the history of a remarkable case, which Mr. Solly has recorded in vol. xl. of the 'Medico-Chirurgical Transactions.' It must be allowed that the precise nature of the tumour in this case is doubtful; but other instances (although very few) of this kind of spontaneous cure are recorded.¹ Its occurrence would be known by the obliteration of the tube of communication between the sac and the laminae, and the feeling of those bones ossified beneath the tumour. Under these circumstances, an operation for the removal of the tumour is justifiable, though it can hardly be considered necessary.

2. Congenital tumours inside the spinal canal are of very various kinds. The most important are found in the sacral region, and these have been discussed in a preceding page.

3. The question of included parasites has also been discussed above.

In considering the question of removing a false spina bifida, its connection to the spinal canal, and to the great cavities of the body (as the pelvis), must be carefully investigated; and in the pelvic region a thorough examination of the rectum and genital organs must be made. If the tumour is free from both these sources of danger, it may be operated on without scruple. If it be in such close connection to the canal as to lead to the inference that it springs from its interior, but still, from its unvarying size under pressure and from other circumstances, a hope is entertained that it may have no communication with the membranes, it may be made the subject of treatment, should the symptoms justify interference. In that case, if the tumour be purely cystic, iodine injection is no doubt the proper measure (see the case related above); but in mixed cystic tumours this will probably fail. It may be tried, however, if the cyst bears a large relation to the bulk of the whole tumour; and it is not till after its failure that it would be advisable to debate the very difficult and doubtful question of excision.

IMPERFORATE RECTUM is a deformity which, though sufficiently rare to prevent most practitioners from having much individual experience of it, is yet common enough to cost the lives of many children every year. Now most of those who have seen much of children's diseases will agree that the lives of the majority of these patients might have been saved, and the patients restored to perfect health, by very simple means, had the medical attendants been more familiar with the nature and treatment of the deformity.

¹ In a debate at the Soc. de Chir. de Paris (*Bulletin*, 1860, p. 387) M. Debout is reported to have said that he only knew of five cases of spontaneous cure: three in the coccygeal region, and two in the lumbar.

In some cases, it is true, life can hardly be preserved; in some it can be preserved only at the cost of the infirmity of an artificial anus; but these are the minority; in the greater number, if a very simple operation be performed promptly, no traces of deformity will remain in after life. It is very important, therefore, to be familiar with the several kinds of this malformation and with the treatment which each of them requires.

Cases are sometimes met with in which the anus is only partially obstructed. Of this rare form of malformation the following instance occurred to me. A female infant a few days old was sent to the Hospital for Sick Children, who had a faecal fistula in the back part of the vagina, but was said to pass faeces also naturally by the anus. Believing, however, that such a fistula could only be accounted for by a congenital defect, I examined the anus, and found it would hardly admit a common probe. The rest of the aperture was blocked up by a membrane of no great thickness. The fistula which communicated with the vagina was much larger than the orifice of the anus; so that hardly any faeces passed by the latter. I enlarged the anus to the proper extent by freely incising the membrane, and keeping the part dilated with a good-sized bougie. By the time the anus would easily admit the little finger, the fistula seemed nearly closed, and little or no faecal matter passed. After this I lost sight of the patient.

Cases of imperforate rectum may be divided into two classes, viz. those in which no anus exists (imperforate *anus* properly so called), and those in which there is an anus leading into a cul-de-sac (imperforate *rectum* in the narrower sense of the term). The former class (imperforate anus) may be again subdivided into—1. membranous obstruction of the anus; 2. complete or partial absence of the rectum; 3. communication of the rectum with the vagina in the female; 4. communications with the urinary tract in the male; 5. external communication, or fistula. The latter class (imperforate rectum) may be subdivided into—1. membranous obstruction; 2. deficiency of the upper portion of the rectum.

Imperforate anus is so far a less dangerous affection than imperforate rectum, that it attracts immediate notice. Either at the time of delivery, or very soon after, the medical attendant or the nurse observes that the natural opening is absent, or that there is an unnatural one. In cases of imperforate rectum, on the other hand, the malformation is overlooked, and the child's sufferings are at first attributed to every cause except the right one.

A. Imperforate anus. 1. *Membranous obstruction.*—When a child is born with imperforate anus and without faecal fistula, the first question is, whether it is not merely an example of the first of the five subdivisions above enumerated. These cases of membranous closure of the anus constitute, I believe, a great majority of the whole; and a simple incision obviates all danger to life. This simple variety is known by the bulging, at the situation of the anus, which is seen when the child cries; and also, if the membrane is thin, by the colour of the meconium being seen more or less distinctly through it. But in order that either of these signs may be noticed, the gut must be distended with meconium, which is not always the case at the time of birth. However, if the gut be not full, the child will not suffer any inconvenience; so that in a case of imperforate anus where no bulging can be seen, and no symptoms are present, it is right to wait for a certain time (varying with the progress of the case—a day may be taken as an average), in order to allow time for the descent of the meconium, before undertaking any treatment. When bulging is perceived, all that is necessary is to make an incision of sufficient size in the situation of the natural anus, and give exit to the contents of the gut. This being done, some of the tissue on either side of the incision may be cut away, in order that the opening may be less liable to close, and it must be maintained open by passing a small bougie, or the end of the finger, into it daily, or twice a day, for some weeks. Whether the incision is to be a simple one in the middle line, or a crucial one, appears to be a matter of indifference; but the former is quite sufficient, and the latter is open to the theoretical objection that the fibres of the external sphincter, which is present in these cases,¹ may be injured. After this operation, if indeed a proceeding so simple deserves the name of an operation, the infant is usually restored immediately to perfect health, and the parts in after life have all the natural appearance and functions. But if no treatment be undertaken (which is unfortunately too common, in consequence of a kind of general impression of the necessary fatality of the malformation), the abdomen becomes tumid and hard, the infant refuses the breast, vomiting comes on, which soon becomes stercoraceous, and the patient dies in a few days from exhaustion, or more rapidly from bursting of the intestine.² If the symptoms have come on before the child is seen, the aspect of the case is less promising; but the same course should be pursued. In a case under my care, in which the child was in a state of great distress from distension and faecal vomiting, rapid recovery ensued on the restoration of the natural passage.

2. *Complete or partial absence of the rectum.*—When no bulging is perceived, after waiting for a reasonable time, it is probable that the lower end of the rectum is deficient. In such a case, if the external parts exhibit no obvious malformation, an exploratory operation should be performed, the object of which is to discover the end of the rectum, and if possible to draw it down, and attach it to the skin in the situation of the anus. For this purpose a free incision should be made from a short distance behind the scrotum, or vulva, in the middle line, to the point of the coccyx; the parts should be carefully dissected, the dissection being conducted along the front of the coccyx and sacrum; and if a bulging tumour can be felt, it

¹ See *Path. Soc. Trans.* vol. v. p. 176.

² The intestine has given way as early as the fourth day. *Path. Soc. Trans.* vol. ii. p. 226. *Curling Med.-Chir. Trans.* vol. xliii. p. 305.

should be gently drawn downwards by means of hooked forceps and brought down, if possible, to the skin, attached there by sutures on either side, and opened; but if this is not possible, it should be opened *in situ*, and after the evacuation of the meconium, gentle traction by forceps should be used to draw it down as far as possible. If the gut can be attached on either side to the skin, the risk of subsequent contraction of the orifice is much diminished, and the danger of extravasation of feces into the cavity of the pelvis avoided. If this cannot be done, the opening must be maintained by the daily passage of a bougie, or other dilating instrument. I have found a pair of dressing forceps a convenient instrument for gently dilating the opening. If the opening can be kept to a proper size, even when the gut has not been drawn down, the power of controlling the feces may be hoped for. A sphincter muscle has been proved by dissection to exist in a case of this kind of malformation: but if the gut have been attached to the skin, its circular fibres will assume the office of a sphincter, even when no external sphincter exists.

When the rectum is entirely absent, the above proceeding will fail. The dissection will disclose no bulging tumour; and then the surgeon will be justified in proposing to open a higher part of the large intestine, and form an artificial anus, in order to save the child's life. The questions connected with this operation will be considered presently.

In cases of imperforate anus where malformation is obvious externally, the parts of generation being very far back, the tuberosities of the ischia very near together, and perhaps the skin in the situation of the anus much depressed, there is more reason to fear that the rectum is altogether wanting, and more danger of wounding the male bladder, or the female uterus and vagina, and the peritoneal pouches, in the dissection, than where the parts are more naturally formed. In such cases, the exploratory operation must be conducted with great caution; and if the above characters are very marked, it will become a serious question whether it would not be justifiable to resort to colotomy at once. It will, however, in most (if not in all) cases be possible, and be the more prudent course, to make an opening between the coccyx and the parts of generation sufficiently large to introduce the finger and feel for the rectum; but in these cases great care must be taken not to injure the parts in front.

3. *The rectum communicating with the vagina.*—The third variety of imperforate anus is that in which the rectum ends either by a small sinus, or by a continuation of its entire tube, in the posterior commissure of the vagina. This is a far less serious defect primarily than the former, since the feces pass in sufficient quantity to avoid any serious symptoms, and an infant does not suffer any material inconvenience from the flow of feces through the vagina. Hence the parents often do not present the child for treatment till it is several weeks or months old. But the secondary consequences of the deformity are usually very serious. The sinus is often not large enough to permit of a sufficient evacuation of the gut, when, with advancing life, the feces become more solid. This gives rise to increasing distension of the colon, which has sometimes proceeded to a frightful extent and proved the direct cause of death.¹ Besides, the disgusting nature of the infirmity calls for prompt treatment before the child is old enough to be sensible of its inconveniences. These inconveniences, however, vary very considerably. Thus a case has been recorded by M. Le Fort² in which a married woman was discovered on rectal examination to have imperforate anus, the rectum opening obliquely into the back of the vagina. In this case the command over the feces was so perfect that no inconvenience resulted; and neither she, nor her husband, nor the accoucheur who had delivered her three times, was aware that there was any peculiarity about the sexual organs. Such cases as these should not be interfered with. On the other hand, when the communication is either so small as to oppose an obstacle to defecation, or so large and destitute of sphincter-power as to entail the disgusting consequences of recto-vaginal fistula in after life, no time should be lost in commencing the operative treatment.

Signor Rizzoli³ has given an interesting account of four cases of this malformation, in all of which he succeeded in restoring the parts completely to their natural relations and appearance by dissecting away the end of the rectum from the back of the vagina, through a free incision in the median line, and then bringing down and fixing the end of the gut in the natural position of the anus, after which the parts between the anus and vulva were united by sutures so as to form the new perinæum. In some of the cases the lower portion of the rectum was so contracted that it was necessary to open it freely in order to obtain a sufficient anal orifice; and in some cases the difference in length between the anterior and posterior walls of the gut, due to its curved direction, caused some difficulty in drawing it down to the proper position. This difficulty however was overcome by careful dissection. The accompanying figures from Signor Rizzoli's work well illustrate this method of operation.

There is usually no difficulty in finding the end of the rectum, by passing a director down the unnatural opening. The perinæum should then be freely divided from a short distance behind the posterior commissure of the labia nearly to the coccyx: and after having, if necessary, opened the rectum by cutting on the director, the operator should endeavour to draw down its walls, separating the front wall from the vagina, and attach them to the skin. If

¹ *Brit. Med. Journ.* 1858, p. 845.

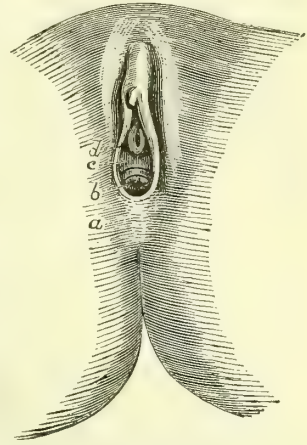
² Le Fort, *Des Vices de Conformation de l'Utérus et du Vagin*. Paris, 1863, p. 120. M. Ricord also has put on record a case in which a woman was in the constant habit of sexual intercourse, and ad lived with one man for three years, without his suspecting any malformation. *Gaz des Hôp.* 1833, p. 412.

³ *Mémoire chirurgique ed ostétriche*, vol. ii. p. 321. Bologna, 1869.

this cannot be done, at any rate a free opening must be maintained in the situation of the natural anus, in the hope that the recto-vaginal fistula may close, which, if it be small, appears to be the case tolerably often. If it does not close, some plastic proceeding analogous to that which is used for rupture of the perinæum in the adult will probably be necessary. But for the success of such operations the bowels must be more under control than can be the case in early infancy; so that it is advisable to delay the operation, and to ascertain, by experiment, before performing it, that the child's bowels can be kept constipated for several days without danger. Dr. Rhea Barton succeeded in effecting a cure by the simpler method of laying all the parts open from the vaginal fistula down to the natural situation of the anus, and then encouraging the front part of the wound to close, while the back part was kept open. Another American surgeon successfully repeated the same operation.¹

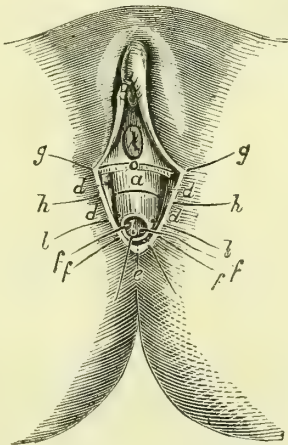
4. *The rectum communicating with the urinary tract.*—Communications between the lower end of the bowel and the male urinary organs with imperforate anus constitute perhaps the most troublesome variety of this affection. It is true that the malformation does not prove immediately fatal, since the fæces are at first sufficiently liquid to pass by the urethra without much residuum. But as they become more solid, a residuum is left, which, being impacted in the urethra or bladder, according to the level of the communication, produces the ordinary symptoms of calculus, with perhaps even more than the ordinary amount of retention of urine. It is important, therefore, to operate before this has taken place. The communication may be either with the urethra or the bladder. In the former case, it may in some instances possibly be discovered by the sound; but usually the seat of the communication remains uncertain. Should the gut terminate in the urethra the rectum will only be deficient in its lowest part, and its termination will be accessible from the perinæum. Therefore, the proper course is to begin by performing the usual exploratory operation in the perinæum: and if the rectum be met with, to separate it from its connections, if possible, and draw it down to the skin, as in the last

FIG. 200.—The parts before operation.



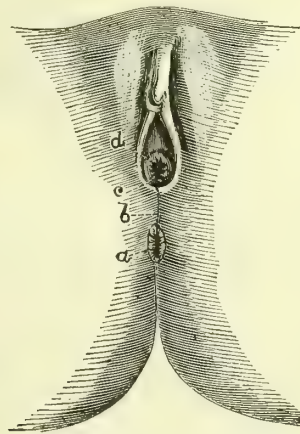
a, the perinæum, extending to the coccyx; *b*, the opening of the rectum into the vulva; *c*, a fibrous membrane continuous with the hymen (*d*), and uniting the labia majora to each other and the rectum.

FIG. 201.—Diagram of the operation.



a, the lower part of the rectum, which has been exposed by a free incision in the median line, extending through the tissue marked (*c*) in the last figure, and drawn down towards the coccyx (*e*); *b*, anal opening of the rectum; *c*, remains of the membrane continuous with the hymen; *d d d d*, the divided muscles and other tissues of the perinæum; *f f f f*, two sutures passed through the lower end of the rectum, securing it in its new position; *g g h h*, sutures, uniting the divided perineal tissues; *i i*, a suture uniting the perineal tissues to the anterior edge of the rectum.

FIG. 202.—The parts after operation.



a, the anal orifice of the rectum in its normal position; *b*, the median incision united and forming the raphe of the new perinæum; *c*, remains of the tissue marked with the same letter in the previous figures; *d*, the hymen, somewhat displaced backwards by the tense membrane *c*. This was the only abnormal appearance which the parts presented after the operation.

case. I am not aware, however, of a case in which this has been successfully accomplished. If the rectum be not found, the inference is that the communication is with the bladder, and in that case the rectum may be totally absent, and the communicating intestine may

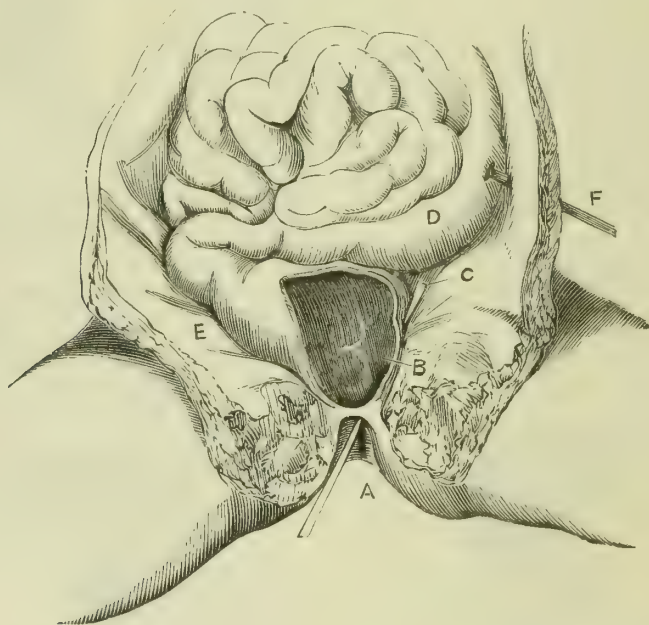
¹ Bodenhamer, *Congenital Malformations of the Rectum and Anus*. Cases cxvii, cxcviii.

be some much higher part of the alimentary tube. In such a case, I think that colotomy should be recommended; but it is a very doubtful question, the decision of which may reasonably be left to the parents, if they are persons of sufficient intelligence. Some further remarks on colotomy in these cases will be found in a future paragraph.

If the child is not seen till a later period, when the symptoms of faecal accumulation in the urinary tract call for some relief, attention must first be directed to this accumulation. The mass must be broken down with the catheter, and removed by the free injection of warm water; or if it be very solid, it may even be advisable to use the lithotrite. Then the case must be treated according to the rules above laid down. The proposal, which has been sanctioned by some surgeons, of cutting down in the middle line into the urethra and neck of the bladder, and thus laying the whole track for the urine and faeces into one, appears unadvisable, as it would very likely end in leaving the patient with the horrible infirmity of a large cloacal aperture, through which both the urine and faeces would pass without control.

5. *Imperforate anus with faecal fistula.*—The cases of imperforate anus in which a fistula exists opening externally are not immediately threatening to life; and if the external opening

FIG. 203.—Imperforate Rectum. Failure of exploratory puncture. Littre's operation.



A, anal cul-de-sac; B, rectal cul-de-sac; C, probe passed in the course of the trocar, which had been thrust behind and to the left of the bowel; D, descending colon; E, the sigmoid flexure passing over into the right groin; F, the colon opened by Littre's operation in the left groin.

be in a situation where the discharge of the faeces will not be dangerous or very inconvenient (e.g. behind the natural position of the anus), it may be a question whether they require any treatment beyond such dilatation as may be necessary for the perfectly free discharge of the faeces. Such openings have been known ultimately to acquire sphincter power. But when the opening lies in front of the natural position (in the scrotum, or close to the vulva, according to the sex), it is advisable to cut down in the proper place, and attach the gut to the skin. The operator may be sure of finding the rectum lying close to the skin of the perinaeum. If the abnormal anus be in some remote place (as in the hypogastrium, on the dorsum penis, in the groin), the case assumes a much graver aspect, since the rectum, and perhaps the whole large intestine, may be absent or impervious. In most of such cases it will, in all probability, be judged better to dilate the abnormal anus, if necessary, and abandon the case to nature. In very few instances would it be justifiable to attempt to restore the natural opening.

B. *Imperforate rectum.*—We have now to consider the cases of imperforate rectum in the narrower sense of the term, i.e. cases in which the external parts are normal, but the anus leads into a small cul-de-sac, the rectum being totally obstructed above. Such cases (as has been before pointed out) usually require immediate treatment; the deformity having been at first overlooked. The obstruction of the rectum may be due to a simple membrane stretched across the tube in the intestine which in other respects is natural; or the upper tube (the rectal cul-de-sac as it is called) may lie by the side of the lower (the anal cul-de-sac), or behind

it; or the rectum may be impervious for a greater or less distance, so that the colon may terminate by a dilated extremity above the pelvis. In rare cases, the sigmoid flexure itself, and more or less of the rest of the large intestine, may be absent; but as such infants are usually not viable, the cases present little practical interest. Practically, cases of imperforate rectum may be divided, as above, into two classes, i.e. 1. where the upper cul-de-sac is accessible from the lower; and 2 where it is not.

The chief means of distinguishing one variety from the other is the sensation of bulging communicated to the finger passed into the anal cul-de-sac. The presence of this symptom may be taken as indicating that the two cul-de-sacs lie close together. As a matter of prognosis it ought to be borne in mind that this bulging has been felt in a case where it proved to be due not to the impulse of feces in the rectum, but to that of fluid in the recto-uterine pouch of the peritonæum;¹ but as an indication for practice it may always be held to justify the surgeon in exploring the bulging tumour. This may be done either by incision or with a grooved needle. If a puncture is made and meconium escapes, the puncture ought to be dilated with a pair of dressing forceps passed through it, until the meconium has been freely discharged, when a large catheter or tube should be fixed in the gut. If the surgeon prefers to use a grooved needle, and meconium is detected, the grooved needle may be used as a director, and a small knife be passed along it. M. Guersant has recommended the use of a trocar and cannula made in a peculiar form, so that the cannula is grooved; but as a grooved needle answers every purpose, I should not be disposed to use a larger instrument. The practice usually pursued, of thrusting about trocars of considerable size in the tissues of the pelvis, is very dangerous; and if the gut is found, the opening made by such an instrument is always insufficient; so that the trocar ought to be discarded in these exploratory operations.

Numerous instances are on record in which the surgeon has failed to detect the presence of the rectal cul-de-sac with the trocar, although that portion of the bowel has lain close to the anal cul-de-sac. I have figured such a case in my work on the 'Surgical Treatment of Children's Diseases,' p. 172, in which Littre's operation was subsequently performed, under the impression that the lower bowel was totally deficient. A similar case, under the care of the late M. Robert, is figured by M. Larcher in his translation of the above-named work, and I reproduce it here (fig. 203), since it illustrates another point which will be referred to further on.

If the gut cannot be found in this way (i.e. if there is no bulging tumour, or if the sensation prove deceptive), an operation similar to that for imperforate anus should be first performed. The anal cul-de-sac should be freely laid open towards the coccyx, and the parts in the pelvis dissected to as great a depth as may be thought prudent. On the failure of this operation, the question of colotomy will arise.

COLOTOMY IN CONGENITAL OBSTRUCTIONS OF THE LOWER BOWEL.—When the rectum is entirely deficient, the only means of preserving life is to open some higher part of the bowel; and when the gut opens into the bladder, and is inaccessible from the perinæum, the same operation may be performed, although not immediately necessary for the preservation of life, as a means of avoiding the grave inconveniences and dangers which that malformation entails. The operation may be performed either according to Littre's method, or that which goes by the name of Amussat.² But the former is generally preferred in these cases of congenital malformation for several reasons, although it must be allowed that our experience of either is not sufficient at present to serve as a foundation for any very exact comparison. It may be said, however, that the only difference between the two operations is, that Littre's is performed a little lower down and farther forward than Amussat's, and that the former necessarily opens the peritoneal cavity, while the latter may succeed in opening the intestine without wounding the peritonæum, in those cases in which the descending colon is not attached by a mesentery. But the latter advantage cannot be always attained, since the presence of a mesentery is not uncommon; and if there be a very long mesentery, it may be altogether impossible to find the large intestine.³ Nor does it appear at all certain that the fatality of colotomy in these cases is due in any great measure to wound of the peritonæum. The tender age of the child; the weakness induced by distension, vomiting, and want of nourishment; and the tendency to peritonitis (in some cases its actual existence), from the congestion and straining motions of the intestines, sufficiently account for the fatal result which usually follows.⁴

M. Guersant opened the colon eleven times in the groin, and once in the loins, without saving one of his patients.⁵ I have only been able to find two successful cases recorded since the publication of M. Rochard's paper,⁶ although that publication must have given rise to the performance of many similar operations. In the first case,⁷ which occurred under the care of Dr. Pooley in the State of New York, the operation was performed on an otherwise

¹ *Path. Soc. Trans.* vol. xi. p. 99.

² These operations are described in the essay on DISEASES OF THE INTESTINES.

³ Mr. Curling practised both operations on the bodies of 20 infants who had attained the full period. Colotomy in the left groin was easy in 18 cases; in the other 2 the bowel curved over to the right side, so that to open it the incision must have been in the right groin. Colotomy in the left loin was easy in 8 of these subjects; difficult in 6; and impossible, without wounding the peritonæum, in the other 6. Curling, *Diseases of the Rectum*, 3d ed. pp. 222, 223.

⁴ On the question of wounds of the peritonæum in operations, see the essay on INJURIES OF THE ABDOMEN, vol. i. p. 893.

⁵ Debout, in *Bull. de Thér.* tom. xlix. p. 116.

⁶ Rochard, *Bulletin de l'Acad. imp. de Méd.* an 1859.

⁷ *Am. Journ. of Obstetrics*, May 1, 1870.

healthy male child in whom there was imperforate rectum and a communication with the bladder. The report was published six months after the operation, the child being then in perfect health. The fæces passed about twice a day from the artificial opening, and the fæcal discharge from the bladder appeared to have quite ceased. The second case is reported by Mr. Marrant Baker in the 'Clin. Trans.' (vol. xii. p. 240). The operation was Amussat's; there was no difficulty in finding the bowel, and the child was in good health five years after the operation, wearing a flexible tracheotomy tube in the opening. M. Giraudeau, however, had a case of colotomy for imperforate anus in which the child lived $2\frac{1}{2}$ months, and died from another cause.¹

In the rare cases where colotomy has been successful, some of the patients have lived through the ordinary term of human life, and have been able to perform without serious inconvenience the duties of laborious occupations, and the functions of wives and mothers.² These cases justify the performance of the operation, with the consent of the patient's friends, although it must be admitted that little success can be anticipated.

When the operation has been performed on account of a communication with the bladder, an additional annoyance is experienced in the fact that some fæces may still pass beyond the artificial anus and reproduce the symptoms of vesical irritation. The surgeon must either deal with the symptoms as they arise, by breaking down the masses in the bladder from time to time, or he may make trial of a plug inserted into the lower opening, or he may even feel justified in attempting to close the latter by a plastic operation. Space will not permit of a discussion of this rare complication; an interesting example of which is, however, recorded by Mr. Curling.³

A curious discussion has been originated by M. Huguier,⁴ viz. whether in performing Littre's operation in cases of imperforate anus, it would not be better to operate in the right groin instead of the left. He has noticed that in many cases of total absence of the rectum, the oblique bend in the colon, of which I have just spoken, brings it to terminate in the right groin. Hence he recommends to make the incision on this side instead of the left. But all the successful cases which have been put on record have been operated on in the left groin; while no operation, so far as I know, has yet been practised on Huguier's suggestion, except one, which is related by Mr. Bryant in his work on 'Surgical Diseases of Childhood,' p. 40. In this case after failing to reach the bowel by an exploratory operation in the perinæum, Mr. Bryant cut down on the right side by a 'vertical incision, at the distance of one inch from the anterior superior spinous process, towards the umbilicus,' and at once found a portion of large intestine, which was proved, after the death of the patient, to be the descending colon. This case, then, shows that M. Huguier's suggestion is so far practicable, that in some, at any rate, of these cases of malformation it is possible to reach the descending colon on the right side of the belly. The same fact is shown by a case which I have related in my work on 'Children's Diseases,' p. 166; and by a case recorded by Mr. Ashton in the 'Path. Soc. Trans.' vi. 200, and many others. But this by no means settles the question. Allowing that in some cases the sigmoid flexure of the colon may be reached from the right side, two questions present themselves: 1. In these very cases could not the large intestine have been opened also from the left groin? 2. If not, is the proportion of such cases sufficient to justify the proceeding? With respect to the first question, I cannot find any precise details on which to found an answer. Mr. Bryant does not describe the relations of the colon in his case in terms sufficiently precise to show that he had given particular attention to this point. In M. Robert's case, figured on page 790, it is plain that the colon could have been found with equal ease in either groin. In Mr. Ashton's case in the 'Path. Soc. Trans.' vol. vi. he says that 'the ascending and transverse portions of the colon were normal: this intestine then descended a short distance on the left side, and, recrossing the abdomen to the right side, terminated in a dilated pouch,' &c. Here, then, if the operator had cut down on the left side, and had not found the large intestine, enlargement of the wound upwards (not necessarily to a very great extent, considering the size of the parts) would have brought the descending colon into reach. What M. Huguier says may be very true, that from the right groin some portion of the large intestine is sure to be reached; but it seems to me to be by no means a matter of indifference whether the part opened be the descending part of the colon or the cæcum; and unless it could be shown that the sigmoid flexure is always, or almost always, on the right side, I should be decidedly in favour of the operation on the left side. The reverse, however, is, I think, very clearly shown. Thus M. Giraudeau says,⁵ 'Numerous anatomical investigations, together with the records of those of Curling and Arthur Bourcart, have shown me that in the great majority of cases in the fetus and new-born child the sigmoid flexure is placed on the left, and not on the right. In 134 autopsies below the age of a fortnight, I found the sigmoid flexure on the left side in 114; in 50 cases of Littre's operation which I have collected, the operator always met with the sigmoid flexure on the left side; in 30 post-mortem examinations of infants operated on for imperforation, the intestine was always found on the left; in 100 examinations of new-born children, Curling found the sigmoid flexure on the

¹ *Nouveau Dictionnaire de Méd. et Chir. prat.* tom. ii. p. 633.

² Curling, *op. cit.* p. 229. Rochard, *op. cit.*

³ *Bulletin de l'Acad. imp. de Méd. tom. xxiv.* 1858-9, pp. 435, 445.

⁴ *Op. cit.* p. 226.

⁵ *Leçons cliniques*, p. 121. M. Giraudeau refers here to two cases in which, in performing Littre's operation, he came upon an undescended testicle.

left side 85 times, and Bourcart, who made prolonged researches in order to elucidate this question, found the sigmoid flexure in its normal position 117 times out of 150.⁷

The incision in the right flank has indeed this recommendation, that should the large intestine be altogether absent, a lower part of the remaining intestinal tube will more probably be reached on the right side than on the left. Such a malformation, however, must be very rare; and the infant would, I should suppose, be hardly viable.¹

I am still disposed to recommend the operation in the left groin in these cases, though with hesitation, looking to Mr. Morrant Baker's experience. Whether after failing to find the sigmoid flexure in that part, it would be the better course to make an artificial anus in the small intestine, or to perform a second operation in the opposite groin, must be left to the discretion of the operator. Neither course would have much prospect of success; but if the infant were healthy and strong, the latter might be justifiable.

In the 'Bull. de l'Acad. de Méd.' tom. xxiv. 1858-9, p. 434, Velpeau gives the following advice. He operated on an infant with imperforate anus. Not being able to find the rectum by operation in the perinæum, he resorted to lumbar and then to inguinal colotomy, but gives no particulars of the operations. On the death of the infant, the rectum was found complete, but empty, and deviated to the right. He therefore advises that, after having opened the gut in the loins or groin, a probe should be passed down to ascertain whether the lower part of the gut is not present, and whether it may not be possible to establish the natural anus.

IMPERFORATION OF THE SMALL INTESTINE.—Two cases of congenital obstruction of the lower part of the small intestine have been communicated by M. Depaul to the 'Acad. imp. de Méd.,' in which the diagnosis was successfully established; the following being the symptoms principally relied on. There were the usual symptoms of obstruction—the abdomen was swollen, the anus and rectum were natural, clysters would pass, but soon returned without meconium; ² a flexible tube could be introduced for a considerable distance, but brought away no fæces; rather seemed to cause vomiting, the vomit being mixed with lumps of meconium. In a case of this sort auscultation and percussion would yield indispensable data. Littre's operation, at the point indicated by the part at which the intestinal resonance seems to stop (especially if the fluid injected can be heard to stop near the same point), appears the appropriate treatment, though little hope can be entertained of good from anything.

MALFORMATIONS OF THE UMBILICUS.—Another affection, probably due to congenital malformation, is that warty or nipple-like tumour projecting from the umbilicus, which is tolerably often seen in children, and seems due to some morbid condition left by the separation of the umbilical cord. Mr. Athol Johnstone, to whom we appear to owe our first accurate description of the disease in the English language,³ speaks of it as 'a stout nipple-shaped papilla or tubercle, rising from the centre of the main umbilical depression;' and says that he has seen it attain the height and circumference of an inch. I have had several cases, but none of this size. Mr. Cooper Forster and Mr. Bryant also speak of this affection. In most cases the tumour is solid, in some a minute canal extends along it for a short (but only a short) distance. No water flows along this little canal, nor does the canal lead into the bladder. The treatment of these cases is exceedingly simple; a ligature tightly applied being all that is necessary.

UMBILICAL FISTULÆ.—There are other though less common cases in which the urachus remains open ⁴ and the urine is discharged from the navel; or in which there is a fæcal fistula congenital or acquired; ⁵ or in which there is a biliary fistula at the navel.⁶ These cases must

¹ In one curious case, recorded in the *Path. Soc. Trans.* vol. xii. p. 87, there was a kind of transposition of the large intestine, the ilioæcal valve being in the left instead of the right iliac fossa, and the transverse arch of the colon passing from left to right, and terminating in a very large cul-de-sac in the right iliac region. There were also in that case other malformations, not, however, apparently inconsistent with life. An exploratory incision from the perinæum having failed, nothing further was done. In this case, had the course which I should have been inclined to pursue been followed, the cæcum would probably have been opened; but this is, I should suppose, a unique case.

² I once saw a case of the kind in which the diagnosis was rendered erroneous by the fact that we could not pass any large quantity of injection. In fact, it returned almost instantly. After death, however, the obstruction was found quite high in the small intestine. The fulness of the abdomen and the straining of the abdominal muscles were the only causes which I could conjecture for the obstacle to the passage of the injection.

³ *Lectures on the Surgery of Childhood*, 1860, p. 44. The affection is said to have been first pointed out by Dugès, *Dict. de Méd.* en 15 tomes, t. xii. p. 159.

⁴ In the *Méd.-Chir. Trans.* vol. xxxiii. p. 293, there is a case reported by Mr. Paget, of Leicester, of patent urachus, in which the patient, a man æt. 40, laboured under symptoms of stone. The unnatural opening was of large size, an inch in diameter; notwithstanding which he could retain about a pint of water, and only a little escaped in micturition. There was also hernia at the opening. The calculus had formed on a hair, which had probably slipped down accidentally from the pubes. It was extracted by passing the finger down the patent urachus. No operation was attempted on the patent urachus. See also Bryant, *op. cit.* p. 144.

⁵ Cooper Forster, *Surgical Diseases of Children*, p. 107.

⁶ I have seen no published case of this affection; but a boy, æt. 10, was under my care in the year 1862, on account of a discharge of pure bile from the umbilicus. This was said to have followed the removal of one of the warty tumours above described. The fluid responded to the usual tests for bile, and, as well as could be ascertained, was free from any fæcal admixture. The sinus from which this fluid exuded was so minute that I could form no idea of its direction, but it seemed to extend a considerable distance.

be distinguished from the foregoing trivial affection, as can readily be done by the character of the discharge.

The cure of such fistulæ should be attempted, but with caution. The actual or potential cautery applied to their edges can do no harm. It has, however, failed in all the cases that I am acquainted with, and then a plastic operation ought to be attempted. But I cannot encourage the reader to be very sanguine of success by this method either. In the two cases related by Mr. Cooper Forster such an operation was performed; but it does not appear to have succeeded in either. Mr. Bryant's case was not made the subject of any treatment. In mine the treatment by cautery failed, and I lost sight of the child before performing the plastic operation which I contemplated.

A very singular case, the result of malformation of the umbilicus, was sent to me many years ago by Dr. Harland Whiteman, of Putney.

The infant was a male prematurely born, and on its birth the funis was noticed to be bifurcated, and it appeared to Dr. Whiteman as though one bifurcation contained the arteries, and the other the vein. This bifurcation commenced about three inches from the umbilicus, and the part of the cord attached to the belly was marked by a rather thick gelatinous septum. The funis was tied and divided below the bifurcation. Nothing was noticed as being wrong for a fortnight. The nurse was observed to be unwilling to be seen when engaged in dressing the cord, but always replied that 'all was going on right,' until, at the age of about fourteen days, Dr. Whiteman was again summoned on account of a bad smell from the navel, and the nurse having reported that there was something wrong about it. On examination, it was seen that inflammation and ulceration extended to some distance around the umbilicus, and there was also sloughing still going on of the septum and of what remained of the right bifurcation. This bifurcation contained no intestine. The sloughing portion was included in a ligature. The opposite bifurcation (on the infant's left) contained intestine; there was a deep sulcus or fissure at the bottom of it, close to the umbilicus, out of which an offensive faecal discharge continually exuded. Some faeces, however, still passed by the anus: but this ceased as the gut protruded out of the navel, and its whole circumference gradually became ulcerated so that the intestine was divided into two parts at the time that I saw the child. There was then a large coil of intestine hanging out of the belly, and partly everted, the faeces exuding from its open mouth. Another smaller coil, which transmitted no faeces, lay on its right side, separated from it by a slight depression or septum, apparently, as I thought, a part of the mesentery.

It appeared evident that there had been some defect in the closure of the umbilical aperture, probably dependent on the fissured condition of the cord, and that into one of these fissures a herniated portion of the gut had protruded. The ulceration of the intestine, and its ultimate division into two parts, were equally evidently the result of mechanical violence which could not have been applied at the point where Dr. Whiteman tied the cord, even if it were possible (which, of course, it could not be) to overlook a protrusion of more than three inches of small intestine, or to tie it without producing any symptoms for several days. It appeared, therefore, more than probable—in fact nearly certain—that the nurse, ignorant of Dr. Whiteman's reason for leaving so large a part of the cord, had at a later period applied another ligature close to the umbilicus, to hasten its separation, and had unwittingly injured the intestine, which by this time had protruded.

When I saw the infant, its death, if unrelieved, was certain, as the protrusion kept increasing, and the most rational plan seemed to attempt Dupuytren's method of treating artificial anus. The two adjacent portions of intestine were accordingly brought into apposition along their serous surface by means of the *entérotome*, and the blades of the latter instrument were gradually tightened upon them. This plan promised at first to be successful; the intestine was repressed into the belly by the instrument, and on the third day after its application faeces began to pass from the anus. The motions continued to pass entirely per anum for four days, by which time the *entérotome* was separated, when unfortunately, in a fit of coughing, the gut reprotruded, the adhesions which had united its two coils having given way, and the protruding portion became larger than it was before the operation. The child soon died.—The preparation is in St. George's Hospital Museum, Ser. ix. No. 103a.

With this case may be compared one figured in 'Path. Soc. Trans.' vii. 216, the description of which is, however, to me somewhat obscure.

HERMAPHRODITISM.—Most of the malformations of the genito-urinary organs have been treated of in the essays on THE DISEASES OF FEMALE AND MALE ORGANS OF GENERATION. There remains, however, the question of doubtful sex from malformation of the external organs, which is often brought to the surgeon to decide, and, as it seems, is often decided wrongly. The male organs may simulate the female in this way: the corpus spongiosum and the corresponding portion of the urethra are absent: the penis is small and the prepuce imperfectly formed, resembling a large clitoris; the scrotum is split, leaving a gap which represents the vagina; its two halves form cutaneo-adipose folds, representing the labia majora between which is the orifice of the short urethra; and the resemblance may be completed by the testes being retained in the abdomen. The female organs may simulate the male by a great enlargement of the clitoris causing it to resemble the penis, the presence of

the ovaries in the labia,¹ and a very small vaginal orifice like the opening in hypospadias. The majority of cases of spurious hermaphroditism in the female present, however, merely the enlarged condition of the clitoris, and may be recognised for females with tolerable ease, by passing a sound up the urethra into the bladder, and examining by the rectum. The presence of a uterus and vagina between the finger and the sound will then be evident. Even in the rare cases where the ovaries may have descended into the labia, on one on both sides, this method of examination may yet clear up the matter; and if the vaginal opening be large enough to admit the finger, no doubt need exist. The question is often more puzzling in cases which are probably males, with cleft scrotum; as is evidenced by the case quoted by Sir J. Simpson² from Otto, where an individual had lived ten years as a wife with three different men, who was yet afterwards affirmed by the Royal Medical College of Silesia to be a male. At the Pathological Society several years ago a specimen was exhibited which elicited opposite opinions from very good authorities. Nor is it impossible that true hermaphroditism may in some cases exist—that is to say, that some parts of the male and female organs may coexist; as in the case of the sheep, described by Mr. Savory in 'Med.-Chir. Trans.' vol. xlii., where, along with testes and other male organs, there was found a very perfect uterus and vagina. Also in the 'Pathological Transactions,' vol. xi. p. 158, is the account of the dissection of the generative organs from a person regarded (and apparently correctly) as a female, but where a body much resembling a prostate was found; the urethra had the long course of the male, and the vagina could hardly be demonstrated. Some other cases will be found recorded by Sir J. Simpson.³ Leaving aside, however, a few rare cases in which some doubt may exist, the careful examination of the folds simulating labia may detect a testis and cord (or a cord with rudimentary testis) on one side or both; or the proximity of the urethra to the rectum, with the development of the perineum, may prove the sex to be male; or the direct continuity of the supposed vaginal canal with the bladder may show that it is really a male urethra. Occasionally it is said that extroversion of the male bladder has been mistaken for the vulva, or that an adhesion of the penis to the scrotum has caused a doubt of the sex of the child. Such conditions, however, can hardly deceive one who is prepared for their occurrence.

In the few cases where the above tests give only uncertain results, a doubt must be allowed to rest on the sex of the child, which perhaps will be cleared up by the development of the breasts and the propensities displayed at puberty; or which may remain until dissection clears up the difficulty. In all cases of true hermaphroditism the sex would be settled by the intrinsic organs (testes or ovaries) which are found on dissection. When doubt exists as to the sex of a child, it appears more prudent to bring it up as a male than to expose it to the disgusting and disappointing consequences of an attempted marriage.⁴

It is but rarely that operative interference is justifiable in cases of hermaphroditism, and the operation consists always, as far as I am aware, in an attempt to enlarge the vaginal opening, so as to permit of sexual intercourse. A case of the kind under M. Huguier's care, in which the proceeding appears to have been successful, is recorded by M. Léon le Fort.⁵

I am not aware that any plastic operation has hitherto been attempted on hermaphrodite males; nor is there either the same motive or the same prospect of success, for the organs are probably too imperfect to be capable either of penetration or emission.

MALFORMATIONS OF THE SKIN.—The congenital⁶ vascular tumours, or nævi, have been noticed above, with respect to their surgical treatment (TUMOURS, vol. i. p. 272). But besides these tumours, there are other malformations, which consist chiefly in a mere discoloration, often accompanied by a development of hair. Of the more extensive discolorations (which are more common on the face than elsewhere), the common 'port-wine stain' is the most familiar example; and of those attended with development of hair, the ordinary mole. But there are rarer deformities of each kind, or involving a mixture of both kinds. Mr. Athol Johnstone informed me that he was consulted on account of a fine healthy baby, with an irregular dark-brown (almost black) streak extending across the root of the nose and invading the inner extremities of the eyelids on each side. The skin was thickened, and irregularly wrinkled and slightly elevated, and its surface was covered with short dark hairs. In this case the extent of the disease forbade any endeavour to extirpate it, which, however, in such affections it is particularly desirable to do if possible, both as a matter of appearance

¹ This is not so very uncommon. A case was laid before the Royal Medical and Chirurgical Society where Sir W. Lawrence, operating for strangulated inguinal hernia in the female, found the ovary in the sac. Mr. Pott's case is also well known. Dr. Barnes referred to most of the published cases of hernia of the ovary in an interesting paper read at the Royal Med. and Chir. Soc., January 24, 1882.

² *Cycl. of Anat. and Phys.* art. 'Hermaphroditism,' the standard reference on this subject. A somewhat similar case is recorded by Mr. J. Wood in *Path. Trans.* vol. xxiii. p. 169, which is the more valuable because accompanied by careful measurements of the pelvis, which had many female characters.

³ See also a case by Rokitsky. *Centralblatt f. die med. Wissenschaften*, Berlin. Quoted by Larcher *op. cit.* p. 284.

⁴ Mons. Ad. Richard asserted some time since that all hermaphrodites are really males, however much the genital organs may approach the female type. *Union méd.* tom. iii. p. 543. Paris, 1859.

⁵ *Vices de Conformation de l'Utérus et du Vagin*, p. 203. See also Larcher's translation of my work on the *Surgical Treatment of Children's Diseases*, pp. 270 et seq., where several interesting cases of hermaphroditism of various kinds are collected.

⁶ It might be worth while to remind the reader, in passing, that though probably all nævi owe their origin to some congenital condition, yet they are often, perhaps usually, not noticed till a short time after birth.

and from the undoubted liability of moles to become the seat of epithelioma.¹ In the case of extensive maculæ no treatment seems to have any effect. In those less extensive, the skin may be destroyed by some powerful caustic, and thus the less disagreeable deformity of a white scar substituted for the stain. It might be possible perhaps to tattoo some of those maculæ with some substance which should produce a white colour, and the suggestion has, I believe, been made, but I am not aware that it has been followed. This plan could hardly, I should think, be practically useful, except in maculæ sufficiently small for extirpation with the knife or caustic.

MALFORMATIONS OF LIMBS.—The malformations resulting from congenital dislocation and fracture will be found described in the next section, by Mr. Brodhurst. Of other malformations of the limbs it seems hardly necessary to say much. Some of them do not admit of any treatment, and are only interesting in an anatomical and physiological point of view, such as the specimens of entire absence of bones and limbs;² while in others the only question is whether the patients would be more comfortable with or without amputation. In the upper extremity the chief question will be as to the power of motion and prehension in the malformed hand, or claw as the case may be; in the lower, as to the feasibility of adapting a stump to the part before or after amputation. It is therefore but rarely that amputation would be recommended in the upper limb, while in the lower it is often, if not usually, advisable.³

There are other deformities which may be produced by the pressure of the fœtal cord in utero, and in which, though the limb has not been amputated, it is distorted in various directions, and deep grooves are marked upon it where the muscles appear to have become atrophied.⁴ If any treatment can be available in these cases, it must be directed to bringing the limbs gradually into natural position by pressure appropriately directed, and by passive motion, and at the same time stimulating the muscles by friction, liniments, &c.

Polydactylism.—The most frequent malformation about the limbs, and one of the most common in surgical practice, is what is called polydactylism; that is to say, supernumerary fingers and toes. Instances in which a more or less perfect additional thumb exists are very often seen in our hospitals; and numerous examples prove that the defect is often hereditary. It is advisable to remove supernumerary thumbs or fingers early, since they are only in the way; but in doing so some little care is required, as the supernumerary digit often shares in the articulation of the natural one to its metacarpal bone; so that if the whole of the last phalanx of the supernumerary digit were removed, the natural joint would be laid open, and ankylosis might result, which would leave the fingers or thumb stiff and extended; therefore the part must be carefully examined, and if even a doubt exists, the phalanx should not be entirely removed, but, flaps having been cut long enough to cover it, should be divided with bone-nippers near its articulation. No deformity will be perceptible when the child grows up, as the little piece of phalanx left behind will not grow, but will be buried in the soft parts when the hand has attained its full size.⁵

Supernumerary digits, which are seated upon perfect metatarsal bones, are also often attached to supernumerary bones in the tarsus itself; while others are attached to bifurcated extremities of a single metatarsal bone. In some cases the superfluous finger or toe is attached by a thin fold of skin to the continuity of the natural digit, quite away from the joint. In these cases the superfluous digit is rudimentary.

Two cases at least have been put on record in which a double hand existed: one by Mr. Murray, of Brighton, in the 'Med.-Chir. Trans.' xlvii. 29; the other by M. Giralès, in his 'Leçons cliniques sur les Maladies chirurgicales des Enfants,' p. 42. In both cases the bifidity appears to have commenced at the carpus, and in both the thumbs were absent. In Mr. Murray's case no operation was performed, the patient (who was a washerwoman) having been first seen at the age of thirty-eight. In M. Giralès's case the superfluous fingers seem to have been removed (M. Giralès merely says, 'en 1864 j'ai opéré un enfant qui avait les deux mains réunies en une seule'). M. Giralès, however, agrees that the operation was unnecessary, since in this case, as well as in Mr. Murray's, all the eight fingers were movable, and the two parts of which the hand consisted could be firmly opposed to each other, forming a very useful member.

In the foot supernumerary digits are matters of less consequence than in the hand. If there be but one, and that not sufficiently prominent to cause inconvenience in wearing the shoe, or an unsightly breadth of the foot, there can be little motive for interference. Mr. Athol Johnstone has recorded a case in which the remarkable number of nine toes, more or

¹ See a case by Mr. Marrant Baker, *Med.-Chir. Trans.* lxi. 53.

² For an extreme example, see a case figured in *Path. Soc. Trans.* vol. x. p. 308, where all four limbs were entirely absent; and the child (who had attained the age of five and a half, and was healthy and intelligent) consisted of a head, neck, and trunk only. Most of the leading forms of these general malformations of the limbs are figured in M. Larcher's work, already referred to; where will also be found drawings of the instruments which have been adapted to such patients.

³ See a case and drawing by Mr. Lonsdale, *Path. Soc. Trans.* vol. iii. p. 464.

⁴ See a case by Dr. Little, *ibid.* vol. i. p. 331.

⁵ See also on this point Sédillot. *Note sur l'amputation des doigts surnuméraires. Comptes-rendus des séances de la Soc. de Biologie*, sér. 1, tom. v. ann. 1853, p. 145.

less perfect, were found on one foot; and the reader who is curious in this matter will find there a full account of the dissection of the part after removal.¹

Webbed Fingers is another very common deformity; and (unlike supernumerary digits) it usually occurs symmetrically on the two hands. It is most common between the last two fingers. The same condition is also found in the toes; but is a matter of no consequence whatever there. In the hand it appears to be exceedingly desirable to remedy this condition if possible; not merely on account of the use of the fingers, but also as a matter of appearance. The webbed fingers often enjoy a large share of usefulness; and the person can soon accommodate himself to his circumstances; but every visible variation from natural conformation is a source of annoyance and hindrance to a child, and should by all means be remedied if it can be done without danger. Of course nothing is more easy than to cut the fingers apart: the difficulty which is experienced is in preventing their growing together again. Various plans have been adopted. The band having been divided completely down to the cleft, the edges of the wound may be brought together down to the apex of the incision, in order to procure union by the first intention. If the edges will not of themselves come together without force, a portion of skin may be transplanted so as to fill up the cleft; for it is in the cleft that the tendency to cicatrization is manifested.

I would on this head call the reader's attention to the following very ingenious operation, reported by Mr. Barwell in the 'Medical Press and Circular,' April 25, 1866, in a case of webbed fingers—the index, middle, and ring on the left hand—which had already been twice operated on by the usual methods without success.

'I thrust a straight bistoury in a sloping direction from behind forwards through the tissues uniting the index and middle fingers, keeping the blade much closer to the latter, so that, when the whole length of the digits had been separated, so much tissue was left on the forefinger that its edges could be brought neatly together and sewn with wire. The same proceeding was then used at the next interspace, the greater amount of skin being left and sewn round the inner side of the middle finger. Thus the wounds to be filled up lay on the outer side of both middle and ring fingers, and at the fork or point of their bifurcation. Of these wounds an impress was taken on a piece of paper, and the necessary pieces were cut from the haunch in such wise as to leave a portion of skin between the two excavations, and also so as to enable me to lift up each strip-like piece in a loop while it remained attached at either end. The wound in the buttock was closed with silver-wire, the fingers to be covered were thrust through their respective loops, and first the palmar edge was stitched—a process which required much care and ingenuity—then the dorsal aspect was secured, and afterwards the hand and arm were carefully bound *in situ*.

'The child slept well during the first two nights, on the third pain kept her restless, and on the fourth day I removed the bandage and cut away the skin connection with the haunch. The hand had swollen from position, but only a very small part of the implanted skin had died, the rest was fairly united. It is unnecessary to follow the details of the case further; it did uninterruptedly well, and in a month the hand was healed, and passive motion had begun to render the fingers more mobile.'

Another plan is to divide the fingers from each other, and leave the wound to granulate, care being taken to press something like a band of string or metal into the cleft, in order to prevent adhesion there; the foreign body being fastened to a bracelet. Or, which seems the most promising plan, a large metal ring may first be passed through a hole, made at the cleft, and worn there like an earring till the sides of the hole have cicatrised. After the posterior angle of the wound is thus secured against the formation of adhesions, one or other of the above plans may be adopted with better prospect of complete success. But even if the adhesions do form to some extent, and so render the fold between the fingers deeper than natural, this is a much less conspicuous defect than the former, and besides is not irremediable by further operation.

M. Giralès has succeeded in dividing these webs by means of a kind of *entérotome* applied to the web, and gradually tightened, so as to destroy the web in about a week. An instance of the use of this method will be found in Giralès's '*Maladies chir. des Enfants*,' p. 507.²

Hypertrophy of the Limbs occurs, as far as I can judge from the limited number of cases I have seen and met with in books, from two causes; viz. from disease of the vessels, or from a congenital tendency much allied to, if not identical with, that which produces the more limited and striking hypertrophies spoken of below as 'congenital tumours.' In the former class of cases the diseased action results in changes analogous to those produced by chronic inflammation, and similar to those which follow chronic inflammation (though only rarely) in the long bones. Thus I have seen in a case of diffused venous *nævus* (or rather diffused enlargement of all the vessels of the limb, including the veins), the whole leg become larger, harder, hotter, and longer than its fellow, as it is occasionally noticed that the tibia, in chronic inflammation, outgrows its healthy fellow.³

The hypertrophy may affect the whole limb, or only a portion of its length (always, I believe, the lower part), or, a part only of the foot or hand, or, finally, only one or more digits.

¹ *Path. Soc. Trans.* vol. ix. p. 274.

² On the subject of webbed fingers, and all the other deformities, congenital or acquired, of the fingers, I cannot do better than refer the reader to M. Fort's *thèse de concours*, '*Des Différences congénitales et acquises des Doigts*,' Paris, 1869.

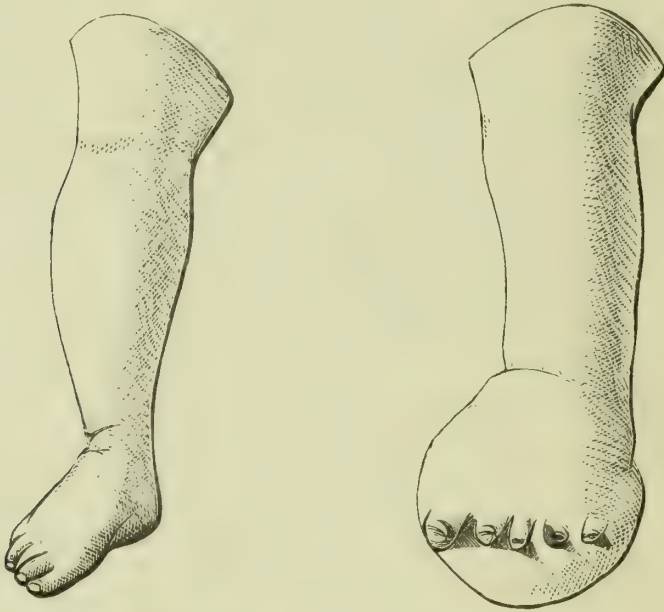
³ See DISEASES OF THE BONES, vol. ii. p. 279.

I do not wish here to speak of the hypertrophy which is an occasional though very rare symptom of extensive disease of the blood-vessels or lymphatics,¹ but only of the truly congenital hypertrophies. These depend upon no known cause;² and although some of them have been found to be complicated with hypertrophy of the walls of the veins, the latter can have no causal relation to the affection. The congenital hypertrophies may be divided into the symmetrical and the unsymmetrical.³ In the former, all the parts of the limb are in due proportion; so that there is nothing unnatural about it beyond its gigantic size. In the latter, the parts are variously deformed by large fatty excrescences, and by over-development of the joint-ends of bones, leading to unnatural position or dislocation of one or more joints. Prof. Busch believes that this unnatural condition of the joint-ends is connected with some morbid growth of the epiphysal cartilage. It leads to irregular enlargement of the articular ends, something like what is seen in rheumatic arthritis; but such enlargement is no necessary accompaniment of overgrowth of the bones. Busch himself has figured (p. 185) the skeleton of a foot in which the bones of the three middle toes are greatly elongated, but all the portions of the elongated bones are in perfect proportion.

The temperature of hypertrophied limbs varies in different instances. In most cases it is normal; in two referred to by Busch it seems to have been diminished,⁴ and in one only increased.

The simple hypertrophy of the cellular and adipose tissues of a limb does not necessarily

FIG. 204.—Hypertrophy of the Foot and Leg. (From casts in St. George's Hospital Museum, representing the two legs of a child, in whom the foot was amputated on account of hypertrophy affecting the subcutaneous and adipose structures.)



include any change in the muscular or bony framework. It is strikingly like the ill-defined hypertrophy which often accompanies and surrounds congenital tumour.

The annexed figure was drawn from a case of the kind. The patient was a child eight months old, in whom the left foot and leg, nearly as high as the knee, were larger than the opposite, and in whom the enlargement of the foot was so inconvenient that, as it was on the increase, the foot was amputated. Anatomical examination showed that the increase in bulk was due only to an unusual deposition of fat and cellular tissue, the muscles as well as the bones being normal.

The amputation of the foot, in this instance, still left the leg considerably larger than its fellow; but when I last saw the child, the limb was steadily diminishing in size under the influence of pressure. I believe that the amputation had been performed under the idea that the disease was of a malignant nature; but the congenital history and the uniform enlarge-

¹ The hypertrophy which is associated with disease of the absorbent vessels will be found treated of at p. 2 of this vol.

² It may be remarked that only in a very few of these cases has any hereditary predisposition been traced.

³ I would refer the reader to Busch in Langenbeck's *Archiv*, vol. vii. p. 174, for a very full account of this subject.

⁴ Mr. Curling's case in *Med.-Chir. Trans.* vol. xxviii. p. 337, and Wulff's in *Petersburger Med. Zeitschr.* 1861, 10. Heft.

ment are symptoms which sufficiently mark the nature of the disease, and exclude all probability of cancer.

Treatment.—In cases where the limb is increased in length as well as in bulk, nothing of course can be done beyond the use of a high sole on the normal foot, unless amputation is thought to be indicated; but where the increase is only in bulk, and is due chiefly (or, as far as can be ascertained, solely) to the enlargement of the celluloso-adipose tissue, much good may be anticipated from carefully-regulated pressure. I have seen a case in which the use of an elastic stocking much diminished the size of the limb; in fact, without it the boy could hardly move about freely: and in the case here represented, where amputation of the foot was performed, the benefit derived from strapping the leg was very marked. As to amputation, I own that I should long hesitate before resorting to so extreme a measure. We know that congenital tumours sometimes disappear spontaneously—why not congenital hypertrophies? especially if assisted by judicious pressure. Besides, the affection is in no degree dangerous to life; nor does it make any very perceptible impression on the general health. And, although a child's gait is awkward with an unnaturally heavy and cumbrous limb, it is, after all, as good as with a wooden leg. As to internal remedies, the liquor potassæ may be tried; but I should not expect much from its use. I should not be indisposed, in a case such as that figured above, to try the effect of tying the main artery of the limb.

When the hypertrophy affects only one or more of the fingers or toes, the question of amputation presents itself in a different point of view. In the foot it is usually advisable to remove the hypertrophied toes as early as possible. In the hand, the surgeon must carefully consider whether the member will be more useful with its gigantic fingers or without them.

In the unsymmetrical hypertrophy, on the other hand, amputation is, as a rule, advisable in the early stage of the disease. As the limb grows, distortion and deformity will surely increase. And when the malformation is complicated by the formation of large celluloso-adipose tumours, or lipomata, on the hypertrophied parts, the operation is still more urgently indicated.

The malformations resulting from the absence of bones or other parts are in the province rather of the instrument-maker than the surgeon. All that can be done is, by some arrangement of splints, and india-rubber bands, to replace the parts wanted, as far as can be; and this is hardly possible in infancy.

T. HOLMES.

CONGENITAL DISLOCATIONS.—Certain dislocations are found at birth. These are especially of the head of the femur. Other luxations occur, however, namely at the knee, the wrist, the elbow, the shoulder, and the jaw. These, however, are always connected with monstrosity, paralysis, or some abnormality of the articular surface itself, and they are rather sub-luxations than true dislocations.

Congenital dislocations of the head of the femur occur in three directions, viz. upwards and outwards, directly upwards, and upwards and forwards. The last-mentioned displacements have only been seen in fetal monstrosities; but the first-mentioned dislocation, that viz. upwards and outwards, is found at birth and without any other abnormality.

Dislocation upwards and outwards, on to the dorsum of the ilium, occurs for the most part as a double luxation, both femora being displaced; and it is seen more frequently in the female than in the male. Thus, Dupuytren¹ records twenty-six cases of this form of dislocation which he himself had observed. Of these three only were single, and the remainder were of both hips. Four only were males.

Thirty-six cases have come under the author's immediate observation; twenty-nine of which were double, and seven were single dislocations. Eight only were males.

Causes.—This dislocation perhaps never occurs except together with a preternatural labour. It occurs especially in breech presentations. Under these circumstances the thighs are flexed upon the abdomen, and the heads of the thigh-bones press upon the inferior and posterior portions of the capsule of the joint. And it is not unusual to hasten the birth either with the hook placed around the top of the thigh, or with the finger similarly placed. But even gentle traction must increase this pressure and tend to cause displacement.

As the head of the bone escapes from the acetabulum the fact is recognised by an acute observer, and a sharp click is heard. Again, sudden traction on the lower limbs may occasion displacement, when there is some impediment to the completion of birth.

Symptoms.—When the dislocation is double the pelvis is inclined forward and the lumbar region is rendered concave—lordosis. The trochanters are abnormally prominent, and they approach the crests of the ilia; and the heads of the thigh-bones are seen projecting on the ilia beneath the glutei. These lie on the dorsum of the ilium above and behind the cotyloid cavity. The general appearance of the figure is accurately given in the accompanying woodcut.

The lower limbs are small, with a tendency to knock-knee and flat-foot. The thighs can be flexed and extended, and adducted; but all these movements are abnormally limited. Abduction, however, is much more limited than the other movements: the thighs can only be slightly separated.

The gait is quite peculiar: none other is like it. It is a rolling motion of the trunk, together with lameness; yet it is rapid and painless.

¹ *Léçons orales.*

When dislocation is on one side only, the limb is shortened and the heel is raised from the ground; and in walking there is much lameness. Except when dislocation is found together with monstrosity, the head of the femur and the acetabulum are in their normal conditions at birth. Changes take place, however, in the course of time, of the head of the bone through attrition, and, also, the acetabulum becomes somewhat filled up. These changes take place slowly, however. When at length the head of the bone passes through the capsule and lies in contact with the ilium, a false articulation commences to be formed. This cavity is lined with a serous membrane, and the head of the bone is retained more or less in position.

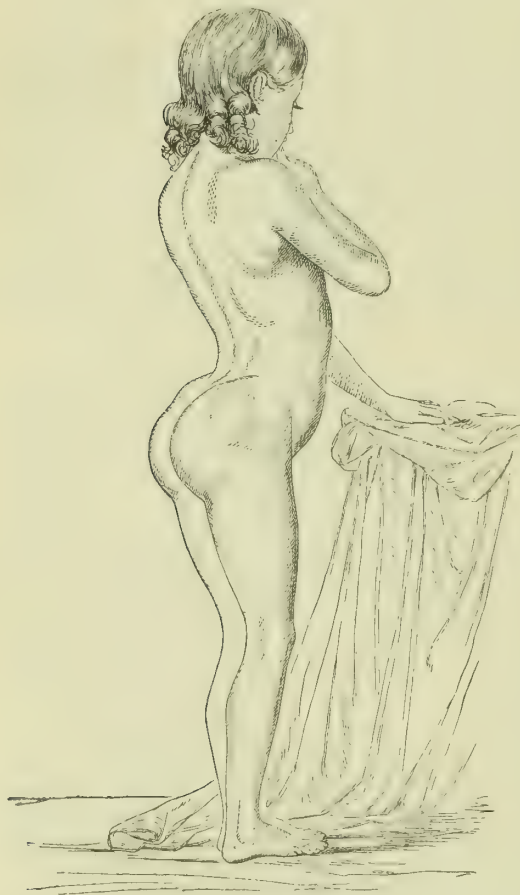
Treatment.—By traction the head of the bone can be restored to the acetabulum. It is difficult, however, to retain it there.

Within some few months after birth dislocation may be reduced by manipulation under chloroform; and the head of the bone will be retained in the acetabulum. At a later period muscular retraction having taken place, the head of the bone, being reduced, becomes again quickly displaced. It is necessary to remove the influence of these muscles before the head

of the femur can be permanently and securely lodged in the acetabulum. This is to be effected by the subcutaneous section of the insertions of the glutei and the rotators into and about the great trochanter.

The mode of operation is as follows: the head of the bone is to be drawn down into the acetabulum, thus rendering the retracted muscles tense, when a strong tenotomy knife is to be introduced beneath the tendons, and these are to be freely divided. The head of the bone then remains in the acetabulum. A thigh-splint and groin-pad effectually prevent subsequent displacement.

FIG. 205.



INTRA-UTERINE FRACTURE.—Fracture *in utero* occurs both of the long bones and of the skull. Fractures of the foetal skull are for the most part incomplete fractures, produced by the forceps of the accoucheur in the passage of the head through the pelvis; and fractures of the long bones result from mechanical injury, and are either simple or compound.

There is, also, another class of cases which has been by some included with fractures, viz. solutions of continuity occurring in a cartilaginous, or imperfectly ossified, skeleton—a condition now known as congenital rickets.

It will not be necessary to allude further to this class of cases. There are many cases on record, however, where fracture after an accident has been found at birth, and which circumstances proved to have existed prior to parturition. Thus, Carus

relates that, immediately after a fall on to the abdomen in the sixth month of pregnancy, the movements of the foetus were unusually violent; but that they then became more and more faint. At the usual time a small, ill-nourished child was born, having the following injuries: viz. a transverse wound on the right leg, three-fourths of an inch in length, and extending from the outer to the inner malleolus; and corresponding to it was a fracture of the tibia. The bone protruded through the skin, and the periosteum was destroyed. The lips of the wound were pale and flabby. Again, Schubert mentions a case of compound fracture of the left femur, where the bone protruded fully one inch, and it was curious.

Mossat relates that on May 10, 1846, he was called to a woman in labour, who, on April 4, climbing over a stile, slipped and fell on to the upper rail, striking her right side. She was unable to move from the spot for a considerable time, but at length she walked home. It was a first pregnancy, and the labour was natural. The child had an ununited fracture of the humerus, in the lower third. There was much swelling, and the girth of the arm at the seat of fracture was five inches; but the girth of the sound arm at the corresponding part

was not more than two inches and three-fourths. The right thigh, also, was thickened by osseous tissue, and the limb was shortened.

A case of some interest is recorded¹ where there had been a fracture through the epiphysis, with separation of the inner condyle of the femur, and the condyle was displaced forwards and outwards. Three weeks before giving birth to this child, the mother, then in the seventh month of pregnancy, fell down a flight of stairs, striking the abdomen in the fall, and hurting herself considerably. The child's knee at birth was swollen, and presently afterwards there was a discharge of purulent matter.

Montgomery² has recorded the following case. 'I saw,' he says, 'a woman eight months pregnant fall from a window, twenty-five feet, into the stony street, on her face. Her hip-joint was dislocated and her face and hands were cut; but the uterus was not ruptured. She was delivered that night of a dead child, which had some of its bones broken, and which had sustained several other injuries. She recovered perfectly.'

Causes.—These fractures are shown to occur through the pressure of the forceps in the extraction of the fœtus. They occur, also, through *contre-coup*, when the membranes have been ruptured. But, so long as the membranes remain entire and distended by the liquor amnii the effects of *contre-coup* cannot be produced on the fœtus; nor can compression, through the walls of the uterus, produce fracture, so long as the membranes are distended by the liquor amnii. In the case last mentioned, the membranes were ruptured, and thus the effects of *contre-coup* were produced.

With these exceptions, intra-uterine fracture is induced by abnormal muscular action excited mostly by physical injury; and it is due to the sudden and violent action of the muscles of the fœtal limbs.

Treatment.—Fracture having occurred perhaps some weeks before birth, more or less muscular retraction will be found to have taken place, so that the ends of the bone overlap or protrude and cannot perhaps be replaced. Certain muscles are found to prevent the replacement of the bone. Extension renders them rigid, but fails to overcome them. It may be necessary to divide the tendons of these retracted muscles subcutaneously. The limb can then be placed in position and retained, so long as is needful, by suitable splints. It is probable that more than one tendon will have to be divided before this is accomplished. But it is preferable to divide as many tendons as are retracted rather than by continued extension to expose the soft structures to laceration, contusion, or other injury.

B. E. BRODHEURST.

INJURIES IN CHILDHOOD do not require notice here, since each injury has been described in previous pages. All that need be said, is that all injuries, both wounds and fractures, are more hopeful in the child than the adult, when the first shock is over, that they heal more rapidly, and that amputation is less necessary.

CONGENITAL TUMOURS AND OTHER TUMOURS IN CHILDHOOD.—Tumours in childhood do not differ essentially from those in later life; but are usually of looser structure and of more rapid growth. Thus cancer affects the medullary rather than the scirrhous form; it grows quickly and proves speedily fatal if let alone, and, if extirpated, generally returns in a very short time. The eyeball and orbit are its favourite seats; but the bones are frequently affected, and the testicle not uncommonly. The congenital occurrence of cancer is said to have been observed occasionally.³ Amongst innocent tumours, the softer varieties—fibro-cellular, fibro-plastic, &c.—prevail over those of more perfect development. Whatever be the presumed anatomical structure of the tumour, its early removal is imperative; not merely on account of the deformity and functional disturbance which it may produce, but also in order to obviate the effect on the nutritive process which is produced by the rapid growth of a tumour. I have had frequent opportunities of convincing myself that the general health improves quickly, and the child begins to gain flesh and strength, after the removal of a tumour which has previously been increasing rapidly. If so, the inference is obvious, that such rapid growth ought to be rendered impossible, by removing the tumour in its stage of quiescence, in every case where this can safely be done; while, if the growth be advancing, the operation is still more urgently requisite.

The chief peculiarities, however, of tumours in early life are observed in those growths which are congenital. Many congenital tumours are formed by single cysts, which sometimes contain clear serum (as in hydrocele of the neck), sometimes dermoid structures (as in the cysts which frequently present themselves at the upper corner of the orbit), sometimes blood, or fluid exactly like blood (as I have seen in a large cyst occupying the whole thickness of the cheek), at other times various modifications of serum. Again, other congenital tumours are entirely solid;⁴ and although some of them grow rapidly, they have no character of cancer;⁵ while others remain stationary for long periods, and then begin to

¹ *Med.-Chir. Trans.* vol. xliii. p. 121.

² *Exposition of the Signs and Symptoms of Pregnancy*, 2nd ed. p. 680.

³ *Walsh on Cancer*, p. 146. Probably most of these malignant tumours belong, anatomically, to the class of sarcomata.

⁴ See a paper, by the author, on congenital innocent tumours, *Lancet*, May 21 and 28, 1864.

⁵ E.g. the cases numbered 4 and 5 in the paper referred to.

increase.¹ Between these two kinds (the solid and the cystic) there are numerous transitional forms. In the neck, the occurrence of a widely-diffused and rapidly-growing tumour, composed of soft solid, with numerous cysts scattered about it, has often been pointed out;² and a similar admixture of cysts and solid substance is noticed in congenital tumours in other parts of the body, where the cellular tissue is lax, as in the orbit (see case 5 in the paper above referred to). When formed entirely of solid tissue, this solid is usually of a soft consistence, whitish, and resembling udder on section, not yielding any juice, and consisting chiefly of simple nuclei, with more or less cellular tissue interspersed. The same is also generally the composition of the compound or mixed cystic growths in the neck.

The parts in which these tumours are found are very various. Though most common in the neck, they may occur in any part of the body. Mr. T. Smith, however, in a very interesting paper published in the second volume of 'St. Bartholomew's Hospital Reports,' points out the fact that there is as yet no known instance of a congenital cystic tumour in any of the limbs.³ But as they have been found in the most various situations—in the back simulating spina bifida, on the surface of the tongue, in the orbit, in the pharynx, and in the internal organs—we can hardly avoid the conclusion either that this is accidental, or that the congenital tumours which occur in the limbs affect the solid rather than the cystic form. There is, I believe, no essential difference between the two forms.

The congenital tumours which are met with immediately beneath the skin and mucous membrane, are, I believe, usually solid. This was the case in a patient from whom I removed a congenital tumour developed from the deep layer of the skin of the nape of the neck,⁴ and in Mr. Mason's patient, from whom he removed several congenital tumours of the dorsum lingue.⁵ Again, in an infant who died from the development of a tissue of this nature underneath the mucous membrane of the pharynx (probably congenital) which prevented deglutition, I found no cysts in the morbid growth.⁶

FIG. 206.—Congenital Swelling of Lip.



The annexed figure represents a similar congenital growth which I once met with below the mucous membrane of the lip, and which, like the other instances that I have seen of these merely superficial congenital tumours, was destitute of cysts.

In the orbit I have once seen a very singular congenital fibro-cystic growth, which had pressed the eyeball out of the head, leading to its rupture and atrophy, and had then spread some distance on the cheek.

Solid congenital tumours also are sometimes (though rarely) found in the scalp.⁷ Thus, in April 1864, Mr. T. Smith removed at the Hospital for Sick Children a congenital fibrous tumour of large size and lobular form, measuring nearly two inches in one direction by one inch in another, from over the pericranium, to which it was somewhat adherent. It was very hard, so as almost to resemble exostosis in general characters, except that

it was movable, and consisted of purely fibrous elements. The patient was a girl five years of age. The operation was followed by dangerous, I believe fatal, symptoms, which might in all probability have been avoided had the tumour been removed in early infancy.

In Mr. Smith's paper some interesting cases will be found of congenital cystic tumours situated in the middle of the back, and simulating spinal bifida. The relation of congenital cystic tumours of the perinæum and buttocks to spinal cysts and to included foetal remains has been discussed above.

Congenital tumours also form in the viscera, a well-marked example of which is the case of enormous congenital cystic formation in the kidney, proving fatal at the age of 17 months, in Mr. Smith's paper in the 'St. Barth. Hosp. Reports,' vol. ii. p. 19.

In all these cases I think it may fairly be argued that the congenital 'tumour,' as for surgical purposes we must call it, is really nothing more than an exaggeration, as it were, of the normal tissue of the part. The polycystic tumour of the neck may be regarded as an enormous development of the natural areolar spaces and of the septa which separate them; so of the orbit, and of the other tumours developed in the loose tissue beneath the fascia in other situations. The solid superficial tumours are thickenings of the corium, or of the basement tissue of the mucous membrane; the cystic tumour of the kidney, an exaggeration of

¹ *Ibid.* case 3; also Mr. Mason's case of congenital tumour of the tongue, *Path. Soc. Trans.* vols. xv., xviii.

² Mr. Caesar Hawkins, *Med.-Chir. Trans.* vol. xxii. Gurlt, *Die Cystengeschwülste des Halses*, Berlin, 1855.

³ It is to be noticed that Mr. Smith is speaking of cystic tumour. Mr. Adams relates a case in which Mr. Lonsdale removed a congenital fibro-cellular tumour from the arm of an infant. *Path. Soc. Trans.* v. 327.

⁴ *Path. Soc. Trans.* xii. 207.

⁵ *Ibid.* vols. xv., xviii.

⁶ *Lancet*, May 28, 1864, p. 606.

⁷ Dermoid cysts of the scalp and congenital sebaceous tumours will be further treated of in the essay on REGIONAL SURGERY.

the natural structure of that organ. Even in Mr. Mason's case of congenital tumour of the tongue, the growths have great analogy to enormously over-developed papillæ. The same may be said of the congenital thickening sometimes noticed in the sterno-mastoid muscle (see REGIONAL SURGERY).

The progress of these congenital tumours, or hypertrophies, is various and very capricious. Sometimes, after attaining a certain size, they disappear spontaneously; a fact of which Mr. Smith, in the paper above referred to, has given numerous examples. Often, I dare say, they remain stationary during life. But at other times, after an indefinite period of quiescence, they resume active growth. Thus in Mr. Mason's case, above referred to, the tumours had been stationary till the age of twenty-seven, when they began to grow rapidly; and Mr. Smith quotes a case from the '*Revue médicale*' (March 1834), where the same thing took place about the age of fifty. In a paper by Mr. Birkett, read before the Royal Medical and Chirurgical Society,¹ the reader will find some singular histories of tumours of this kind, which attained a great development towards the end of middle life. Again, they may grow steadily in infancy, drawing into themselves the elements of general nutrition, and thus producing marasmus. It is partly in this way, and partly, perhaps, by mechanical pressure, that the congenital polycystic tumours of the neck so often prove fatal at an early period. Occasionally, indeed, the progress of these tumours is as rapid and as inevitably fatal, if not effectually checked, as that of a cancer. Finally, there are some, although these are but few, in which the situation of the mass causes only a slight growth to prove fatal, as in the instance of the tumour behind the pharynx to which I referred above.

The affections from which the congenital solid tumour requires to be diagnosed are cancer, fatty tumour, and degenerated nævus. The cystic tumours require besides to be diagnosed from sebaceous cysts, nævi, and, in certain regions, from spina bifida, meningocele, and included fœtus. From cancer, there is little difficulty in distinguishing any except the more rapidly-growing polycystic tumours of the neck; and in these cases their great extent, lobed arrangement, and the great cysts full of variously-coloured fluid which they contain, sufficiently indicate their nature to any surgeon familiar with the disease.

From fatty tumour the aspect of the growth and the absence of the dimpling generally produced by pinching-up the skin over a fatty tumour may distinguish the ordinary fibro-cellular congenital growths. Still it should be remembered that fatty tumour may occur congenitally. Thus Mr. Athol Johnstone has recorded a case of fatty tumour growing congenitally out of the sacral canal, to which reference has previously been made (p. 781). Mr. Gay has related² a remarkable case of congenital fatty tumour in the sole of the foot, in which part of the foot was amputated under the belief that 'the tumour was of a *recurrent* if not of a decidedly *malignant* nature,' but where it proved to be composed of large meshes of connective tissue, in which were contained fat-cells with margarine crystals in the interior of each. Mr. Gay adds, 'the tumour was free of the deep tissues of the foot, and could have been dissected from the skin.' Mr. Gay's report of this case is very full and interesting, and is illustrated by good representations both of the external and microscopic characters of the tumour. While saying, therefore, that the more ordinary forms of these congenital tumours require to be diagnosed from fatty tumour, we must not forget that in some rare cases, the latter are also congenital.³

From degenerated nævus it is often very difficult to make a diagnosis, indeed impossible without an exploratory puncture; and the difficulty is sometimes increased by the presence of nævus-stain in the skin over the tumour, as in my case in the '*Path. Trans.*' vol. xii. p. 206. But the diagnosis is not in this instance a matter of much practical moment, since the congenital tumour does not require treatment unless in an active state; and this state of activity would of itself be sufficient to show that it could not be a degenerated nævus. From nævus in its active condition these tumours may be distinguished by their wanting that decided change of volume with the respiratory efforts which is always exhibited by large and growing nævi, by their less uniform consistence, and by the results of exploratory puncture. A nævus will bleed copiously on puncture, its tissues will feel soft, and the point of the needle be almost but not quite fixed. In a congenital tumour, if solid, there will be nothing following the puncture except the minutest quantity of blood, the tissue will feel quite hard, and the point of the needle will be fixed. If the instrument has been plunged into a cyst, a fluid of variable character (but not blood) will run freely out of its groove, and the point of the needle will be perfectly free.

The diagnosis of congenital cystic tumour from meningocele and from spina bifida will be best judged of from the account of those affections. (See also REGIONAL SURGERY.)

Treatment.—A congenital tumour which is not active does not require any treatment at all, unless from its position it be very unsightly or productive of some functional disturbance. It is quite certain that a good many of these congenital hypertrophies disappear as the child grows, and that a further proportion remain without advancing in size for an indefinite period. Still if the tumour be only small, and the part be one where no danger is to be apprehended, I think it better to remove such tumours at once, in order to obviate any risk in after-life. In larger tumours, where there would be any danger in such an operation, no treatment should

¹ *Med.-Chir. Trans.* li. 185.

² *Path. Trans.* xiv. 243.

³ Mr. Butlin has collected most of the recorded cases in an article on Fatty Tumours in Infancy and Childhood, *St. Bartholomew's Hospital Reports*, vol. xiii. See also Venning in *Clin. Trans.* ix. 51.

be adopted unless the growth is active. If this is the case, the choice lies between several courses. If the solid material be in very large proportion to the cysts (and of course still more if there be no cysts), I believe no measure short of excision will succeed; but there is no objection to the previous use of discutient ointments or lotions, if the case is not very urgent. Mr. Smith speaks favourably of weak vermilion ointment; but I question much whether the cures which have taken place under the use of any of these discutients have not been spontaneous.

When the cystic element is in large proportion, the obliteration of the cysts is the first object, and is often followed by the total disappearance of the disease. In Mr. Smith's paper several highly-interesting examples are given of the beneficial effects of small setons in this respect, and some of these examples occurred under my own observation. The remedy is a very simple one, produces little disturbance, and hardly any deformity; and, as it is often successful, deserves a trial in any such case. A single fine thread is to be passed through the cyst under treatment, and withdrawn as soon as inflammation commences. After the first seton has produced its effect, a second may be required in another portion of the tumour. In some cases where the cysts were large and not very numerous, I have seen the best result from iodine injection. Other and more severe measures have been used for the same object, as the prolonged use of large setons in order to obliterate the cysts by suppuration; the introduction of sticks of powerful caustics (the '*cautérisation en flèches*' of Maisonneuve); and the incision of the cysts successively, allowing them to granulate up. These measures should, I think, be rejected. I do not see what object is to be gained by the prolonged irritation of large setons beyond what Mr. Smith effects by the harmless action of small ones; and as to the other two methods of treatment, I have tried them both, but only with the effect of hastening the fatal issue; and I regard them as much more dangerous than total removal.

It only remains to inquire under what circumstances the complete excision of the growth is indicated, and to what extent it is likely to succeed. In the first place, if the growth is rapid, some measure must be adopted to check it, otherwise the infant will either die of the local effects of the tumour (e.g. of pressure on the trachea or œsophagus in tumours of the neck), or from the diversion of the elements of nutrition into the tumour he will fall into a condition of weakness, in which he will soon succumb to one of the customary ailments of infancy. In such a case, if the growth be cystic, and the milder measures before spoken of have failed, or if the growth be solid, so that there is no place for them, I think the tumour ought to be removed entire. In the neck the operation is no doubt a formidable one, because these tumours are always below the cervical fascia, and extend to an unknown distance and in various directions among the important structures of the part; and the nearer the tumour approaches to the middle line, the greater is the danger of meddling with it. But then these multiple cystic growths in the neck are very fatal if left alone; and when they have begun unmistakably to take on active growth, there should be no delay in dealing with them efficiently.

In such instances I believe the operation to be called for by the indications which lead us to recommend the removal of tumours in other parts of the body, viz. the immediate effects of the disease, the prospect of danger from the probability of further increase, and the hopelessness of arresting the disease by other means. But one consideration ought not to be overlooked—that is to say, the fact that in many if not in all of these cases, the disease is less a new growth in any proper sense of the word than a hypertrophy extending to an uncertain distance among the tissues, and devoid of any demarcation, so that it is very difficult to determine what must be removed and what may be left behind, and equally so to be quite secure that the disease will not sprout up again if any portion has been left.

In order to illustrate this, I will quote the following case, which occurred to Mr. Prescott Hewett. I am not aware that the case has been published by him, but it has been more than once referred to under his authority.¹ A congenital cystic tumour was excised from the posterior triangle of the neck by the late Mr. Keate, in a female infant æt. six months. A small portion of one of the cysts was left, adhering intimately to the subclavian artery. It was not until the age of thirteen that any renewed growth took place, when she was placed under Mr. Hewett's care with a double cystic tumour below the trapezius muscle and the clavicle, as large as the fist. Suppuration was induced in this by means of a seton. This measure was followed by troublesome cough, and finally an abscess broke into the trachea or œsophagus, and she recovered after vomiting a quart or more of foetid pus. She was seen in good health seventeen years after the operation.

This history shows that in a case in which any minute portion of the cyst-walls has been left behind, there can be no security against the ultimate recurrence of the disease. But, if the previous reasoning is correct, this consideration hardly bears upon the question of treatment. We cannot imagine that there is any more security against recurrence after apparent obliteration by iodine injection or seton. The suppuration which follows in the healing of the excision-wound is certainly more likely to destroy such remains of the cyst, or to deprive them of their secreting powers, than the irritation set up by the other methods of treatment. But such considerations are beside the question if the operation is necessary. I earnestly recommend the operation with all its dangers in certain cases—not of course in place of milder

¹ See Mr. Smith's paper, *op. cit.* p. 21.

measures (injection or seton) when such milder measures have any chance of success—but in place of measures such as caustics and incisions, which, though in appearance milder, are, I am convinced, as dangerous and far less successful.

CONGENITAL OR HEREDITARY, AND INFANTILE SYPHILIS.—The poison of syphilis, when it has been conveyed into the constitution from an infecting sore, saturates the blood, and vitiates, as it would appear, the composition of many of the secretions, and amongst others of the semen. From the ovum (i.e. from the blood), or from the semen, according as it is the mother or father who is the subject of the original disease, the fœtus often becomes impregnated. This gives rise to a train of symptoms in the infant, which strikingly resemble, and strikingly differ from, those of secondary syphilis in the adult.¹

It is necessary, however, before describing the symptoms of this disease in the infant, to say a few words as to the origin of the disease, and as to the important and very difficult duties which its occurrence in a family lays upon the surgeon.

That the children of healthy women may be born with the constitutional taint of syphilis is so common an observation, that the old idea of infantile syphilis being always, or very often, the result of direct inoculation from a sore existing in the vulva of the mother at the time of parturition, is contradicted by every-day experience, no less than by the character of the disease, in which a chancre is perhaps never, at any rate exceedingly rarely, met with. It is theoretically possible that the child might be so infected; but if that were ever the case, the disease would bear a much stronger resemblance to those unfortunate cases in which surgeons contract syphilitic disease from inoculation of a crack on the finger, during the examination of a venereal sore, than to the ordinary congenital disease here referred to. Still the possibility of such a catastrophe renders it incumbent on a surgeon, when delivering a woman who has a chancre in the vulva, to defend the infant as far as possible from contact with the secretions of the sore, by coagulating its surface with nitrate of silver and coating it with collodion.

Practically, however, the *congenital* disease, in the proper sense of the word, is always derived from the blood or semen of one or both parents. Therefore when an infant is born, in whom (by the symptoms which will be shortly described) congenital syphilis is diagnosed, it is the duty of the medical attendant to discover which of the parents is affected, and not to allow (if possible) further cohabitation until the secondary symptoms have entirely disappeared, under the treatment which has been above described in the essay on SYPHILIS. Neglect of this precaution may not only entail on the couple the misery of a family of deformed, puny, and ailing children, but to the woman at least is fraught with grave personal danger. Whatever may be the case among the poor, there is no doubt that in the better classes congenital syphilis is usually derived from the father; the woman being uninfected except through the fœtus. Now it has, I think, been proved that a healthy woman carrying a syphilitic fœtus, may become infected with constitutional or secondary syphilis, through the exchange of components which goes on between the foetal and maternal blood in the placenta. Thus are explained some of those cases in which women, who have never had primary syphilis, have shown all the symptoms of secondary syphilis after living for some years with husbands suffering from secondary symptoms.² There seems also some reason to believe that after such an infection of the sound parent, the disease in the future offspring will be rendered more intense.

Again, children may be affected with syphilis in vaccination, or by contact with syphilitic sores on the persons of wet-nurses or others. We shall recur to this, more strictly speaking, *infantile* variety of the disease, after having described the symptoms of that which is truly congenital.

Symptoms.—The popular name for this disease—the snuffles—indicates one of its most striking features—a discharge which collects in the nose, blocking it up sometimes entirely, so that the infant is unable to suck for any length of time. In extreme cases, this inability to suck becomes a grave, and even dangerous, part of the disease. The nasal discharge is thought, with great probability, to be due to the presence on the mucous membrane of an eruption analogous to the cutaneous syphilide, which constitutes the principal manifestation of syphilis in the infant. This eruption differs from any of those seen in the adult, most probably in consequence of the different consistence of the skin in early infancy. The spots are usually somewhat coppery, but sometimes of a perfect rose colour, and more resemble roseola than any other of the ordinary eruptions; but the eruption is moister than roseola in the adult. On the soles of the feet and palms of the hands the cuticle usually scales off, and the eruption resembles psoriasis. On the other hand, where the cuticle is very thin, and kept moist by the folds of the skin or by discharges (as about the vulva and perinæum, near the anus and mouth, or in the groin), flat mucous tubercles are usually met with. Eruptions are also met with in the mouth in the form of white ulcers or patches, displaying the crescentic outline so common in various syphilitic affections of the skin. Together with these symptoms there is also observed, in nearly every case of congenital syphilis, a clear indication of the profound affection of the constitution, in the wizened and shrunken look, the anxious expression, and

¹ The general question of the connection between the hereditary and the more common forms of syphilis will be found discussed in the essay on that subject. See p. 345 *et seq.*

² Mr. Jonathan Hutchinson in *Med. Times and Gazette*, vol. ii. 1856, and vol. i. 1857.

the dirty hue of the skin (a kind of dirty-greenish yellow), which imparts to the infant a peculiarly repulsive aspect of old age even at the threshold of life. There are other symptoms which are not so often seen. Thus various eruptions are spoken of as occurring in a later stage of the disease. In some severe cases the eruption rapidly runs on to ulceration, crusts cover the ulcers, and a state resembling that of impetigo is produced. Papular and ecchymatous eruptions are spoken of, but they seem only slight variations of the ordinary skin-disease. Whether pemphigus in infants is often, or ever, due to syphilis is an undecided question. I have seen it in connection, at any rate, with congenital syphilis, if not caused by it.

Within the last few years Prof. Parrot in France, Drs. Barlow, Lees and others in this country, and Dr. Taylor in America, have asserted that lesions of the bones are extremely common in congenital syphilis, and have minutely described the changes in bone which they regard as syphilitic. I will give a short account of the views which these authors advocate, although I am not absolutely convinced of their accuracy. The subject is one of extreme difficulty. It is very hard in a large proportion of the cases to get any satisfactory evidence of the existence of syphilis in either parent; in fact, if we were to insist on this as a *sine quâ non*, more than half the cases on which these doctrines rest would, I think, be excluded from consideration. Many of the cases seem rather to resemble rickets than syphilis; so much so, that M. Parrot has boldly attributed all rickety lesions of bone to hereditary syphilis;¹ an opinion which seems to me altogether erroneous, for every-day experience in private practice shows cases of well-marked rickety lesions in which the existence of hereditary syphilis is absolutely disproved. I do not think that we shall ever arrive at really satisfactory notions as to the essentially syphilitic affections of bones in infancy until we study apart from each other well-marked and really proved cases of syphilis, rickets, and other cachexiæ. I have long been convinced that affections of the bones are common in congenital syphilis, and I have no doubt that many of the affections which are now so described are really due to syphilis; but whether the same or very similar affections do not exist independently of syphilis seems to me very questionable, to say the least. M. Parrot describes, in the paper to which reference has just been made, two chief forms of syphilitic affection—viz. atrophy, and overgrowth or osteophytic production. Atrophy exhibits two varieties—the gelatiniform, much the more common both in the cranium and the bones of the limbs, marked by a disappearance of the lime salts, and the replacement of the bony tissue by a medulla of various shades of colour; and the chondro-calcareous, in which the ossifying tissue between the epiphysis and diaphysis is not organised into true bone, but into a more or less cartilaginous mass permeated with calcareous salts—a sort of imperfect imitation and over-production of the thin lamina which naturally exists below the epiphysal cartilage. Among the consequences of these atrophic affections may be mentioned: *a.* Craniotabes, or that disappearance of the bones of the skull under pressure which leads in some cases to large perforations of the skull in infancy, due apparently to pressure of the head on the pillow. *b.* Bending or fracture of the bones. *c.* When these fractures occur near the epiphyses in cases of the chondro-calcareous form of atrophy, abscess is very likely to ensue, constituting one of the forms of the acute arthritis of infants, described by Mr. T. Smith in the tenth vol. of the 'St. Bartholomew's Hospital Reports.'² In such cases a sort of pseudo-paralysis is produced by the fractures or by the diseased condition of the joint-ends; but the muscles themselves are not really paralysed. The osteophytic or hyperplastic form of syphilitic affection is far more frequently met with than the atrophic. It is also described by Parrot as exhibiting two varieties: one in which the newly-formed tissue presents an osseous consistence—the 'osteoid' variety; and the other, in which it is soft, fibroid, and spongy—the 'rachitic.' The latter is never found before the age of five or six months, while the osteoid variety exists at all ages. The humerus and tibia are the bones most often attacked, then the femur and ulna, and sometimes almost the entire skeleton; but in the latter cases, the bones above named are more extensively diseased than the rest. In the osteoid form, the bony deposit, which is of less regular structure than normal bone, is usually separated from the old shaft by a groove of medullary tissue, and usually consists of various superimposed layers, separated from each other by medulla. The periosteum is usually thickened, and envelopes the whole osteophyte. According to M. Parrot, the seat and external characters of these bony deposits is perfectly diagnostic, for there is no other diathesis which can produce such osteophytes.³ In the rachitic form the new tissue is of a fibroid, spongy consistence, of a pearly or slightly yellow colour, vascular, and containing but little marrow. The osteoid and rachitic varieties may be mixed more or less in the same osteophyte, the osteoid layers being in all cases the more internal; and thus are

¹ Les altérations osseuses, causées par la syphilis héréditaire, ont été prises, et le sont encore chaque jour, pour du rachitis. Faut-il s'en étonner, si l'on songe que la syphilis conduit fatalement au rachitis, et qu'envisagé de la sorte ce mal ne constitue pas une entité pathologique mais simplement un âge, un état particulier, une modalité de la syphilis osseuse due à l'hérédité; si bien que ce n'est plus—suivant la confusion ancienne que je rappelais tout à l'heure—le rachitis qui absorbe ces altérations syphilitiques des os; c'est au contraire la syphilis, qui dans son immense processus englobe le rachitis; ainsi descendu du rang de maladie, qu'il occupait jusqu'ici, à celui d'une simple affection syphilitique ?—*Path. Trans.* xxx. 339.

² See an interesting summary by Dr. Gee of the then published researches of Waldeyer and Köbner, Parrot, Wagner, Guéniot, Ranvier, and Valleix in the *London Med. Record*, 1873, p. 40.

³ This, of course, involves the whole question in dispute. It may, I think, be safely admitted that affections of bone such as are described in the text occur in congenital syphilis; but it is not as yet proved that they are peculiar to, or pathognomonic of, syphilis.

formed sometimes very large projections near the joint-ends of the bones, on the eminences of the cranium, and other parts in which more or less tendency to an imperfect ossification is found. The tendency of the disease is towards cure. The osteophytes usually get modelled down and replaced by bone of normal shape and structure; otherwise caries or necrosis may ensue. The separation or exfoliation of the exposed bone in these as in other syphilitic affections is very slow.¹

Finally, certain lesions or degenerations of the principal viscera have been pointed out as peculiar to congenital syphilis; but I cannot say that the evidence on this subject appears to me very conclusive. Dr. Gee has asserted that some enlargement of the spleen, perceptible externally, exists in about half the cases of congenital syphilis, and that in addition there is in many cases enlargement of the liver and of the lymphatic glands, but the nature of the enlargement of the viscera is still uncertain. Opportunities for post-mortem examination rarely occur, and then the results have been indecisive. Dr. Gee says that the enlargement of the spleen is sometimes the only sign of an active syphilitic cachexia.²

The period at which the disease makes its appearance is a point of much importance in prognosis. Congenital syphilis is a very frequent cause of the death of the foetus, and consequent miscarriage of the mother; that is to say, the foetus is affected at an early period of conception. In other instances the foetus is born alive, but with the characteristic snuffling and eruption; here the infection has not been matured till a late period of foetal life. In the majority of cases, however, which become the subjects of treatment, the infant is perfectly healthy, to all appearance, at birth; and the disease first shows itself after an interval, which is commonly about six weeks. As a general rule, the period of the appearance of the disease varies with its intensity; and this, again, varies with the length of time which has elapsed since the first infection of the parent, and depends also on the fact of one or both parents being diseased.

Besides the above congenital or hereditary disease, infants may be affected with syphilis, as adults also may, by various methods of contact and of inoculation. That primary syphilis is communicated by actual contact to any part of the body where an abrasion exists (or probably without abrasion, where the cuticle is very delicate), is a fact of as much importance in the infant as the adult; and it has been conceded above that possibly syphilis may in some rare cases be so communicated in the act of parturition, and it may also be accidentally inoculated in infancy, as at any period in life, if the infant be brought into direct contact with a person affected with primary syphilis (e.g. the nurse). Secondary syphilis, it seems now agreed, may also be inoculated;³ and this is even more likely to occur to infants than adults, on account of the constant contact in which they are held to the bodies of those who nurse them, the frequency of slight pustules and abrasions on their bodies, and the thinness and moisture of their skins. This second source of acquired syphilis in infants is verified by many recorded cases.⁴ But a third source—and one which, on account of its bearing on public health and public policy, is perhaps even more important—is that inoculation of the vaccine virus, which a wise legislation is now seeking to make generally compulsory in infancy. There seems no possibility of denying that syphilis is in some cases inoculated in vaccination. The facts adduced by Mr. Lee (*SYPHILIS*, pp. 348-9) seem to prove this beyond dispute. It is most consolatory, however, to find that in this country at least this occurrence is so rare that it has never happened in Mr. Lee's own vast experience, nor, I may add, during the many years that I held office at the Hospital for Sick Children did I ever see or hear of a properly authenticated case. Two very characteristic and complete series of cases of vaccino-syphilis related by Mr. Hutchinson will however be found in the sixty-fourth vol. of the '*Med.-Chir. Trans.*'

It appears probable also that direct inoculation of blood from a syphilitic patient may propagate primary syphilis. The experience hitherto accumulated on the subject of vaccino-syphilis renders it probable that the admixture of blood with the lymph has in some at least of the cases been the vehicle for the contagion, and not the lymph itself. In order, then, to guard against the conveyance of syphilis in vaccination, the following precautions should be taken: 1. A clean lancet should be used. 2. The lymph should be taken from the vesicles not later than the eighth day. 3. Lymph only should be taken, and it should be free from the admixture of blood or of other secretions. 4. The lymph should be taken from a healthy subject. It is greatly to be hoped that these precautions may prove sufficient; and we are encouraged to believe that they may, from the extreme rarity and dubiousness of the occurrence of syphilitic infection after vaccination in this country, as well as from the account of the outbreak in Italy, which shows that it is highly probable that the vaccinator had neglected Mr. Lee's fourth caution; and that if he had carefully examined the infant who was the source of all this mischief, he would have found evidences of existing syphilis.⁵

¹ See J. Hutchinson, *Path. Trans.* xxxi. 248, 250.

² See Gee, *Med.-Chir. Soc. Proc.* vol. ii. p. 260. Barlow, *Path. Trans.* xxvii. 354.

³ See the essay on *SYPHILIS*, p. 339.

⁴ E.g. the celebrated case of Chiabrera, the source of the late vaccino-syphilitic eruption at Rivalta, spoken of in the essay on *SYPHILIS*, p. 348.

⁵ It must be allowed, however, that the indications of syphilis in the vacciner, though probably always present, are sometimes such as demand a more complete examination than is ordinarily made for their detection. Thus the vacciner in Mr. Hutchinson's first series of cases was a child of the most healthy

It will be observed that the *infantile* disease, contracted by contact or inoculation, differs in no respect from the usual forms of primary syphilis, except in the seat of the original chancre, and therefore no more need be said about it here. The importance, however, of knowing, and acting upon, the fact that infants may be infected in this manner and may then become the source of contagion to their previously healthy parents or attendants, rendered it necessary to notice the subject.

There are other sources from which an infant may be infected with syphilis while at the breast. It appears to have been now put beyond doubt that the lesions of secondary, as well as those of primary, syphilis are capable of producing the infecting chancre.¹ We may conclude from the facts of every-day experience that such secondary lesions are not sufficiently contagious to convey the disease, except after prolonged and intimate contact, and to a part where the cuticle is either abraded or very delicate: but there are facts which appear to prove that infants (in whom both these conditions meet together) do occasionally contract primary syphilis by contact with persons affected with primary or secondary sores. This occurs most usually where they are suckled by women labouring under syphilis (particularly when the syphilitic lesions affect the nipple or mamma), and the part infected is usually the mouth. When, therefore, a child at the breast of a wet-nurse shows symptoms of secondary syphilis some weeks after birth, it will be proper to examine carefully, and see whether such symptoms resemble the truly hereditary form of the disease described above, or whether they do not follow on the occurrence of a chancre on the lip, attended by enlarged submaxillary glands. These cases occupy more space in foreign works, probably because wet-nursing is more common abroad than in England; and it appears very usual for wet-nurses to be infected in the nipple by suckling syphilitic infants. In such a condition it is easy to imagine that they might give suck to their own or other uninfected infants, and so a chancre be produced.² Nor are cases wanting in which children have been said to be infected in other ways and in other parts of the body.³ But in all these cases the disease, though differing in its seat and alleged exciting cause from ordinary syphilis, differs from it in no other respect; and an attentive examination will usually clear up all difficulties even at some distance of time from the first appearance of the chancre. The treatment must be the same as for ordinary infecting chancre or its sequelæ.

It is perhaps hardly necessary for me to do more than allude in the most cursory manner to the case in which the infant infects the nurse. I have never seen an instance in which this has occurred when the mother has been the nurse, although she might be quite free from any trace of present or past syphilis; but it is impossible to doubt that when suckled by healthy wet-nurses syphilitic infants have often proved the source of contagion. The chancre appears on the areola of the nipple, is accompanied by indurated glands in the axilla, and is followed by alopecia, sore throat, and syphilitic eruptions. Cases of the conveyance of the disease to the husband from women so infected are given by foreign authors; but are to be received as true only after the most rigorous examination—if indeed any examination can entirely justify the assumption.

Diagnosis.—The diagnosis of syphilis in children, whether hereditary or acquired, does not usually present much difficulty. The snuffles, the eruption, the condylomata or mucous tubercles, and peculiar cachexia of the congenital disease when present, together with its persistence, are usually sufficient to characterise the complaint even when its history is concealed or unknown. Non-syphilitic roseolous or other eruptions might no doubt occur together with coryza; but such eruptions (and still more the ordinary strophulous affection) yield readily to simple treatment. In a few doubtful cases I have found the child's general condition improve so rapidly under the influence of mercury, that I have no doubt of the propriety of administering that drug when we have good reason for suspicion, but cannot form an absolutely certain diagnosis. In the acquired disease, if seen in an early stage, the appearance of the sores, the enlarged glands which are generally connected with them, and the examination of the mother, nurse, or attendant, will usually clear up the diagnosis. Later on, the eruptions, alopecia, and affections of other organs, must be diagnosed by the same rules as secondary syphilis in the adult; but as the disease is so much rarer in children, more caution will be necessary. In a case of suspected vaccino-syphilis, the points to which attention should be directed in forming the diagnosis are, the state of health of the child from whom the lymph was obtained—if that can be ascertained—the appearance and secretion of the sores, the character of the bubo, and the presence of secondary symptoms after three or four months.⁴

Prognosis.—The prognosis of hereditary syphilis is usually represented as very favourable, if only the disease be early treated. I must say, however, that I have seen a good number of syphilitic children die; few indeed from the direct results of the disease, but many from

general aspect, who had in fact been selected on that very account; but who had, when afterwards more minutely examined, some condylo nata around the arms.

¹ On this subject see Rollet, *Recherches cliniques et expérimentales sur la Syphilis*, and H. Lee, *op. cit.*

² Rollet, *op. cit.* pp. 256, 263.

³ Thus some of the children who nursed the babies infected by vaccination at Rivalta had sores and suspicious eruptions on their arms and other parts.

⁴ It would be a question for the surgeon himself to determine whether he would think it justifiable, in the case of a doubtful sore after vaccination, to test its inoculability on another part of the child's body. If the surgeon held, with Mr. Lee and others of the best observers, that an inoculable sore is a soft sore, and therefore non-infecting, and therefore not requiring specific treatment, no practical advantage could result from the experiment.

intercurrent infantile disorders of various kinds. It seems often followed by hydrocephalus, which some surgeons regard as part of the disease. In fact, congenital syphilis is a profound cachexia, which renders children far less able to resist any of the numerous febrile disorders to which (especially among the lower classes) they are so much exposed. With this reservation, the prognosis is good for ordinary cases; but those in whom the disease has commenced before birth, and who are extremely stunted and withered, will very probably die, more especially if the nose is so much obstructed as to render sucking difficult.

Treatment.—The only treatment which is at all justifiable in congenital syphilis is the administration of mercury; and the only question therefore is as to the most advantageous way of administering that drug. The method of inunction recommended by Sir B. Brodie is quite sufficient: this is managed by merely keeping a flannel band, smeared with ung. hydrarg. twice a day, constantly applied to the thigh or the arm for about six weeks. This is the most convenient plan in private practice, or where the surgeon can make sure that his directions are implicitly followed; but in hospital practice I have found it more safe to give the drug in the form of medicine—a plan in which the ignorant have more confidence; a grain and a half or two grains of grey powder, with a little of the compound chalk-powder to prevent irritation, may be given night and morning. The calomel vapour-bath may be used, if the parent or nurse is also infected. Whatever be the form selected, the course should be carried on for full six weeks, by which time the eruption will most probably have disappeared and the child have regained its plumpness and healthy complexion. If not, the mercury should be continued until the cure is complete.

The local treatment is of subordinate importance. In the essay on DISEASES OF THE NOSE (vol. ii. p. 636), Mr. Durham and Mr. Haward insist on the necessity of removing foul discharges which may become a source of irritation and so propagate disease to the nasal bones. Ulcerations about the genitals may be touched with solutions of caustic or sulphate of copper; and the ordinary applications may be used to sores in other parts. But these measures have little real value beyond their cleansing efficacy. With a sufficient course of mercury, simple cleanliness is usually all that is necessary; without it no local applications do much good.

The remoter effects of congenital syphilis are either direct or indirect. As the ordinary congenital disease bears a considerable resemblance to the secondary symptoms in adults, so there are seen phenomena analogous to the ordinary tertiary symptoms, although we are hardly as yet able to say whether such tertiary symptoms are common or no. The researches of Mr. Hutchinson on interstitial keratitis, and on the deafness which appears to be sometimes a consequence of congenital syphilis, are well known, and have been alluded to above.¹ Another remote consequence of congenital syphilis which Mr. Hutchinson has pointed out is the condition of the permanent teeth,² the central pair of incisors in the upper jaw presenting the peculiarities of being generally ill developed, usually small in size and therefore separated from each other, of soft consistence, and marked at a short distance from their free edge by a crescentic notch from which one or more tubercles project, so that the edge of the tooth is notched, lobulated, or irregular. These tubercles soon wear off in consequence of the softness of the teeth, leaving the edge of the tooth crescentic. Syphilitic teeth are also very liable to caries; but the irregularities here spoken of exist in those which are not carious, and are far better observed in such. The same or similar peculiarities may be presented by the outer incisors of the upper jaw, by the lower incisors, and by the canine teeth; but they are less marked, and are not relied upon as diagnostic by Mr. Hutchinson. Both his papers are well worth reading, and his views have been supported by experience hitherto; although the whole question is so difficult on account of the length of time which has elapsed between the supposed cause and its observed results, and also on account of the nature of the disease, that it is very hard in many cases to say whether they tend to support Mr. Hutchinson's views or not.³ It is certainly important in a diagnostic point of view to be familiar with this alleged syphilitic condition of the central permanent incisors; not to confound it with the numerous other irregularities to which the teeth are liable from hereditary or personal peculiarity, from disease and from neglect; and I may be allowed to add, not to forget that Mr. Hutchinson's doctrine is not intended to apply to the temporary teeth: these, although they may of course be diseased in syphilitic children, do not show any diagnostic peculiarities.

Finally, there are some other tertiary symptoms which are occasionally seen connected with old attacks of hereditary syphilis, but so rarely that the nature of the connection can hardly yet be said to be settled. Thus I have spoken in the note of a case in which destructive ulceration of the soft palate took place in connection with many of the symptoms of congenital syphilis; in another case I have seen laryngitis, requiring tracheotomy, in connection with interstitial keratitis, total deafness (acquired), and lupus exedens. And in

¹ See DISEASES OF THE EYE, vol. ii. p. 35; DISEASES OF THE EAR, vol. ii. d. 155.

² *Path. Soc. Trans.* vol. ix. p. 440; vol. x. p. 287. See also the illustration in the essay on DISEASES OF THE EYE, vol. ii. p. 36.

³ For instance, I had some time since a patient aged about twelve, in whom the condition of the teeth and of the cornea was strongly indicative of congenital syphilis; he had also lost the soft palate from ulceration; and the very striking improvement which followed the use of iodide of potassium alone, with no other medicine either local or general, strongly supported my first impression that the case was one of tertiary congenital syphilis. Yet I could obtain no account of the original disease; and the occurrence of syphilis in either parent was denied, and with all apparent sincerity.

connection with the latter disease (which appears to be, though rarely, a symptom of the later stages of syphilis in adults, especially in hot climates) I may say that I was informed by my friend Mr. Naylor that he had seen a case of vaccino-syphilis where the whole arm was covered by a copious eruption of well-marked lupus. That some of the diseases of the bones so common in weakly children may be due to tertiary congenital syphilis is, as I have remarked above, probable, but I think not yet proved.

The treatment of these later stages of syphilis is pretty nearly identical in children and in adults.

INFANTILE PARALYSIS.—The morbid anatomy of this singular affection is now much better understood than formerly, chiefly in-consequence of the labours of Charcot,¹ although we must allow that our knowledge of its essential nature and causation is still as deficient as ever. The disease often comes on with no warning whatever; sometimes after or in the course of a fever of some sort, and very frequently with a symptomatic fever of its own. The paralysis is then immediately noticed. It is often incomplete, but in many cases it advances rapidly till the muscles affected are not only completely paralysed, but completely insensitive to either galvanic or faradic stimulation. Then the affected muscles begin to waste rapidly, and the temperature of the paralysed limbs falls to a very marked degree. There is, however, no loss of tactile sensibility, and the functions of the bladder and rectum are unaffected. Pain seems not to be at all a constant symptom, but from the early date of the invasion of the disease it is difficult to get exact information on this head. The usual period for the commencement of the disease is between one and five years of age, the majority of cases beginning in the second year. Thus Dr. West says that out of thirty-two cases in which this point was noted, nineteen began between eight months and three years of age. The disease, however, is not unknown at later periods of childhood, and M. Duchenne has proved the existence in the adult of a paralytic affection in all respects similar to infantile paralysis.

After the first period of the disease—that of advancing paralysis—which lasts a very variable period (the average being stated by Dr. Bristowe as between two and six months), there follows in most, though not in all, cases a second stage of recession of the paralysis in some if not in all the muscles affected. This ends in the most fortunate cases, which, however, are unfortunately a small minority, in complete recovery. More commonly, while some of the muscles regain more or less power and muscular excitability, the rest remain paralysed. The ultimate stage is one in which the affected muscles remain entirely atrophied and useless. Wasting of the paralysed muscles is early noticed and often advances rapidly. The muscular fibres seem affected at first with simple atrophy, and this is said by Charcot to have been detected three weeks after the onset of the disease in muscular fibres removed by M. Duchenne with the ‘*emporte-pièce*.’ Subsequently a good deal of fatty degeneration usually follows, and the cellular tissue is often loaded with fat, so that the muscle recovers a good deal of its former size, masking the real atrophy. In other cases the muscle almost disappears. The bones also are considerably atrophied and sometimes much shortened, and this sometimes even in cases where the affection of the muscles has not been severe, while the size of the blood-vessels is diminished in proportion to the loss of bulk and warmth of the limb.

The essential anatomical lesion appears from the researches of M. Charcot, supported as they are by observations from Vulpian, Duchenne, Lockhart Clarke, and others, to be seated in the motor cells of the anterior horn of the grey matter of the cord. The central grey substance is also sometimes affected, and the neuroglia shows in many cases considerable sclerosis, leading in some instances to atrophy of the neighbouring nerve-fibres and even to wasting of the whole of that half of the cord, but all these are looked on by him as secondary to the wasting of the motor cells of the anterior cornu, which in the most marked cases is complete, so that the motor cells are replaced by small masses of granular debris, around which the neuroglia will be found probably in a condition of ‘*sclerous atrophy*.’ Post-mortem examinations quoted by Charcot in two cases where death occurred in an early period of the disease seem to show that the early changes in the affected spinal tissues are inflammatory. Though as yet this can scarcely be said to be demonstrated, yet the symptoms and course of the disease have led physicians to the same conclusion, and it may be for the present at least accepted.

There is seldom any difficulty in the diagnosis of the disease, except when its results are presented to the surgeon without any history in cases where only a very limited number of muscles have been affected. Thus infantile paralysis of the muscles around one hip only, leading to wasting of the buttock, has been confounded with hip-disease; or paralysis of the deltoid only with injury to or disease of the shoulder. But the diagnosis is seldom really difficult if sufficient pains be taken. The perfectly free and painless mobility of the joints, the absence of any unnatural position, unnatural size, or inflammatory heat or tenderness in the bones and other deep-seated tissues, sufficiently show that the case is one of simple atrophy, for which no other cause can be conjectured except infantile paralysis. From any other spinal affection, the complete immunity from all trophic lesions, from all impairment of sensation, and from any interference with the functions of the rectum and bladder, will amply suffice to diagnose it.

¹ Charcot, *Diseases of the Nervous System*, 2nd ser. lect. ix. New Syd. Soc.'s Trans. 1881.

The treatment of infantile paralysis is generally unsuccessful. Looking at it as an inflammatory affection, some authors speak of cupping or counter-irritation to the spine in the appropriate region; but I do not think that any benefit has ever been thus obtained, nor does the administration of strychnia seem to have been of any service. After the subsidence of the fever of the initial stage, or in its absence, electricity should be persistently employed to the paralysed muscles, either by means of faradisation or galvanism, as may seem to suit best on an adequate trial. This should be done patiently for many months, even when no good seems to be obtained at first. M. Duchenne has related a case in which faradisation continued over the space of two years was successful in restoring their functions to several muscles of the arm which had been atrophied and insensible to electrical stimuli for four years. Still I fear that it will remain true in general that it is only those muscles which give some indication of returning energy in the first few weeks or months after the onset of the disease which will ultimately derive any benefit, and these are, I believe, undoubtedly both assisted and quickened in their recovery by the judicious employment of electricity.

The sequelæ of infantile paralysis are, however, what more commonly occupy the surgeon's attention. Various forms of clubfoot and a host of other deformities are due to the gradual slow contraction of the healthy muscles, no longer balanced by their paralysed antagonists. In many such instances tenotomy of the healthy muscles, with some appropriate apparatus for maintaining the natural position, will enable the patient to walk, and in some cases the mere application of an apparatus with elastic bands to replace or assist the paralysed muscles will suffice; for the latter are very often not entirely, but only partially, incapacitated. But when the patient has no power of using his limbs, it is useless to operate, and in all these cases where the power and vitality of the member are much below the normal, all surgical operations which are not plainly indispensable should be avoided.

GANGRENE.—Cases every now and then occur in which gangrene comes on with frightful rapidity, and without any obvious cause, in children—usually those who are debilitated by some previous febrile ailment. Such a case took place some years ago at the Hospital for Sick Children, in the person of a little boy who was convalescent from measles, and about to be discharged. He had made no complaint of any sort, but the nurse in undressing him found both feet black in patches. Three hours before, his stockings had been put on, and the feet were then natural. The child was examined, the case found to be really one of gangrene, and the patient of course put to bed. The gangrene extended with great rapidity, reaching as high as mid-leg next day, when he died. There were also patches of gangrene on the elbow and hand. No cause was discovered on post-mortem examination to account for this rapid invasion of gangrene.¹ Such cases are of course very rare; but in two situations gangrene is very common in childhood—viz. in the face, cancrum oris, and on the vulva, noma vulvæ. The former affection has been already described, having been used in the essay on GANGRENE, vol. i. p. 142, as an illustration of one of its spontaneous forms. The latter form of gangrene is very frequently seen in children's hospitals, though I cannot recall any instance of its spontaneous development in hospital; and from this circumstance, as well as others in its history—viz. the aspect of the children; the rarity, to say the least, of its occurrence amongst the children of the upper classes; and the success attending its treatment—it seems pretty certain that it is the direct consequence of bad food and inattention, more particularly if the child has been previously ill; but cases often occur in children who have had no known illness. And the fact that noma may occur independent of any irritation of the genital organs is proved yet more unmistakably by the occasional commencement of noma pudendi far away from the mucous surface, sometimes even in the skin of the groin. In such cases, again, irritation (such as that of erythema intertrigo) may have preceded; but I have seen instances where no such cause was alleged, and where the sloughing commenced in the fold of the groin. Whether the real exciting cause in these cases is glandular abscess may be sometimes doubtful; but I am confident that I have seen cases where the sloughing commenced in the groin, the genital organs being free from disease. The first symptom noticed is usually a dusky colour of the skin of the labia, and foul discharge, with pain in micturition. The parts swell, and soon assume a gangrenous colour, the slough being bounded by a halo of inflammation extending to the groins. At the same time there is much depression, loss of appetite, and occasionally vomiting. The treatment consists in stopping the extension of the gangrene, supporting the strength, and regulating the condition of the bowels. For the first purpose nothing seems so appropriate and so successful as the application of the strongest nitric acid. This caustic is peculiarly successful in the gangrene of children in all its forms. Sloughing phagedæna in adults often proceeds unchecked after the application of the acid; but in all the cases (which certainly have not been many) that I have seen of its application for sloughing phagedæna in childhood, the gangrene has been at once checked. So also in cancrum oris. Whenever the extent of the disease has been such that it has been possible to steep the whole gangrenous surface in the acid, the disease has been checked. Noma pudendi is not less, in fact it seems to be more, under the influence of this remedy; and there are few cases which will resist its timely and thorough application, if conjoined with the proper measures of general support; but the application must be both thorough and timely. As soon as the disease has declared itself, or as soon as the child is brought under treatment, chloroform is

¹ *British Medical Journal*, 1857, p. 387.

to be administered, the parts well separated by an assistant, and the whole of the sloughing surface freely steeped in the acid. Next day, should any part appear to have escaped the application, or should the gangrene be spreading in any part, that part should be again freely cauterised in the same way. Some surgeons prefer the actual cautery, but I have found the nitric acid so successful that hitherto I have had no experience of any other caustic. After the cauterisation, a poultice should be applied to hasten the separation of the slough, and a lotion of carbolic acid may be poured into or placed around the poultice to correct the fætor. A purge may be given at first, if the tongue is foul, and bark with chlorate of potash, or with ammonia, or some other diffusible stimulant, given in as large doses as can be borne—wine and food being allowed as freely as the child will take it. In cases where the general strength is not extremely depressed, and where this treatment is adopted early, it is almost uniformly successful; but in the opposite circumstances, even though the gangrene may be stopped, the child, without any obvious symptoms, will sink and die. No post-mortem appearances are found in such cases. After recovery there appears to be little deformity; but I have had no opportunity of seeing whether any trace of the ravages of this disease persists in after life.

The reader may find in the '*Lancet*, 1850, vol. ii. p. 578, the account of a case under Sir W. Fergusson's care, where the vulva became entirely obstructed by adhesion of the labia majora in ulceration or sloughing following on measles. This is not expressly related as a case of noma pudendi, although perhaps it ought to have been, measles being one of the recognised causes of that affection. In the cases of noma which I have myself seen, the vaginal opening has seemed rather widened than contracted. In noma, however, and all other ulcerative affections in these parts, it is our duty not to lose sight of the child till the surface is soundly healed and contraction is no longer to be apprehended. If contraction is impending or is recent, it may perhaps still be possible to dilate the parts. In case of old contraction or adhesion of the labia, some plastic operation will in all probability be required. In the case referred to, the adherent labia were simple separated, and an attempt made to keep them apart; but the success was imperfect.

INFANTILE LEUCORRHOEA.—The vagina in children also sympathises in the child's general condition in another way, which very often falls under the surgeon's notice. This disease occurs as a copious discharge of a purulent or muco-purulent fluid, much resembling the discharge of gonorrhœa, and usually supposed by the child's mother to be the result of impure connection. In the great majority of cases no such connection has occurred, and the suspicion ought to be dispelled from the minds of the parents, as it frequently gives rise to unfounded charges. But in a few cases there is no doubt that a criminal assault has been the source of the disease. No diagnosis, as far as I am aware, can be made between the ordinary infantile leucorrhœa and a gonorrhœal discharge which has been caused by connection unaccompanied by violence,¹ except in some very rare instances in which, the child having been seen very soon after the occurrence, spermatozoa have been detected in the vagina.² But if any force has been used, either to compel the child to submit, or in order to effect penetration, the marks of bruising or laceration will afford valuable evidence. The common infantile leucorrhœa comes on with some inflammation of the parts, causing a good deal of itching and complaint in passing water. The labia are swollen and red, and often more or less excoriated. The discharge soon sinks into a chronic condition, and may remain so for an indefinite time. The general health is usually more or less feeble, and the child often suffers from worms. Attention to the state of the general health and of the bowels, fresh air, chalybeates, scrupulous cleanliness, and the liberal use of astringent injections, will usually cure the complaint; but it is often slow in subsiding. Care must be taken in injecting to use a small syringe, and do no violence to the parts; and it is advisable to dry the vulva well afterwards, and smear some oil or lard over it to obviate the contact of the discharge. If the disease be known or suspected to be gonorrhœal, little variation need be made in the treatment; except perhaps that, as the complaint will commence with more acute symptoms, poppy fomentation may be used for the first few days, and the child kept to bed.

CONDYLOMATA are not common in children, notwithstanding the frequency of vaginal discharge. Mucous tubercle is a very common symptom of congenital syphilis; but it is usually under the influence of mercurial applications, combined with the internal use of mercury; in more obstinate cases the acid nitrate of mercury may be required, and is pretty sure to remove the tubercle. It is but rarely that we are called on to treat in childhood the large villous masses of condylomata that so often come before us in adults, when the subjects of venereal affections. In children, condylomata may be safely and efficiently treated under chloroform by removal with scissors and searing the base with the actual cautery; if the growth is at all large, it is far better to resort at once to this radical operation—which gives no pain, or very little, when the cautery-iron is thoroughly applied—rather than to trust to the slower and more painful action of the potential cauteries, though these will succeed in slight cases if combined with the most scrupulous cleanliness.

¹ Mr. Cooper Forster gives a curious case, in which a woman communicated gonorrhœa to two girls by washing them with her own sponge. *Op. cit.* p. 125.

² I am told that this occurred in a case at King's College Hospital some years ago.

TUMOURS OF THE VAGINA.—The vagina is in some rare cases the seat of soft tumours which, if not congenital, are rapidly developed in very early life. A female infant was under Mr. Athol Johnstone's care some years ago, at the Hospital for Sick Children, in whom a bleeding warty growth existed inside the labia, looking somewhat like ulcerating condyloma, but with no syphilitic history. It had been treated by a course of mercury for some months at another hospital as syphilitic, but got worse. The application of the acid nitrate of mercury effected a cure. In another case under my care the vagina was filled with a large mass of semi-solid matter mixed with cysts, looking something like a bunch of grapes. I pulled away as much as I could, and applied a caustic to the base of the tumour; but whether with permanent success I do not know, as the child was removed from the hospital by her mother. Such tumours may be excised if their attachments render it possible; but even then the free hæmorrhage that would be produced is undesirable in infancy. In the case just described it would have been impossible to cut away the tumour, in consequence of the small size of the vagina and the depth from which the mass protruded. Probably caustics would be in all cases the best, and of these the acids or the benzine or electric cautery would be the most manageable.

T. HOLMES.

RICKETS is a disease peculiar to childhood; for though the effects of rickets are perceptible in the deformity which it produces throughout the whole of life, yet all active symptoms always subside long before puberty. The softening of the bones, which occurs in later life and to which the name of *mollities ossium* has been given, is to be distinguished from the infantile malady.¹

The term 'rickets' has reference to the distorted condition of the bones, especially those of the limbs, which is the most striking feature of the disease.² This, however, is only a symptom of the constitutional cachexia which is the essence of the complaint. As in syphilitic, cancerous, and scrofulous affections of the bones, so in rickets, the local condition is only the expression, as it were, of a latent and undetermined tendency in the whole organism, which, as in the diseases referred to, attacks other parts as well as the bones. But, unlike those diseases, the affection of the bones is in most cases of rickets a matter of far greater practical importance than that of remoter parts. Accordingly, in the short sketch which my space will allow, I shall dwell more on the local than the constitutional features of rickets. Those who desire to obtain a more adequate view of this important subject may consult the valuable lectures of Sir W. Jenner in the 'Medical Times and Gazette,' vol. i. 1860.

The chief symptoms of rickets are as follows: the ends of the long bones and those of the ribs, where they join on to the epiphyses or the costal cartilages, are noticed to become swollen and knobby. This enlargement is particularly perceptible in the carpal ends of the radius and ulna. Soon the limbs become weak, so that sometimes, if the child has begun to walk, it is 'taken off its feet;' or else the power of walking is not attained at the usual time; in other cases the child continues to walk, but at the expense of increasing deformity of the extremities, producing bow legs and deformity of the spine, causing one of the species of curvature. This deformity is a consequence of a peculiar process of softening which goes on in the shafts of the bones. The morbid anatomy of rickety bones has been described with great minuteness by the German anatomists, and in our own language in the excellent lectures of Sir W. Jenner.³ It will be sufficient here to say that the chief changes are a large production of growing tissue at the epiphysal ends, a softening of the bony tissue of the shafts, attended with enlargement of the lacunæ, which are occupied by a red pulpy substance, and a great thickening of the periosteum.⁴ In the flat bones, especially those of the cranium, a considerable increase in the thickness of the whole bone results from this thickening of the periosteum and enlargement of the lacunar tissue, and the large size of the head generally noticed in rickety children is due partly to this thickening of the cranium. The softening of the bones soon reaches such a degree that the bones bend under the influence of external force and of muscular movement. The extent to which each of these mechanical causes influences the curvature of the limbs, of the chest, and of the spine, is a matter of much interest, and of some importance in practice. As to curvatures of the spine and as to pigeon-breast, the reader will find all that is necessary in the essays by Dr. Little on those subjects. Rickety curvature of the limbs is no doubt produced by both causes. Where powerful muscles (as the deltoid) are inserted at an advantageous angle into the shafts of the long bones, deformity is generally very marked in advanced rickets; while, on the other hand, the deformity is as marked in situations, such as the forearm and the tibia, where no adequate muscular force can have been acting on the bone, and where the curve is obviously due to the weight supported by the hand in crawling, in the first instance, and by the legs in walking in the second. The softened bones are also peculiarly liable to fracture from slight causes. These fractures are very frequently unaccompanied by laceration of the periosteum, on account of the slight force

¹ See *Mollities ossium*, in *DISEASES OF THE BONES*, vol. ii. p. 312.

² The term 'rachitis' was originated by a committee of the College of Physicians (one of whom was Glisson), about 1645. 'One of us,' says Glisson, 'in searching for a name, hit upon that of *rachitis*, which took our fancy immediately.' Glisson remarks that the disease which they christened 'rachitis' was vulgarly known by the name of 'rickets' (hence it follows apparently that the latter term is not derived from the former). Can 'rickets' be derived from the old French word *riquet*, which is the same as *bossu*? Some have supposed both 'rickets' and 'riquet' to come from the German *Rücken*.

³ See also M. Broca's researches, quoted, in the translation of my work on *Children's Diseases*, by Dr. Larcher, p. 567.

⁴ See Dr. Mercier, *Disorders of Infantile Development*, p. 157.

that has produced them and the thickened condition of the latter membrane, and are often of the incomplete or 'greenstick' variety. The fragments in many cases are kept in apposition by the thickened periosteum; hence, when the disease is not in a very acute stage, rickety fractures generally unite kindly. Slight causes, however, soon reproduce them; so that rickety children sometimes present almost as miserable (though by no means so hopeless) a condition as adults affected by mollities. The softened condition of the bones also induces deformities of the walls of the great cavities of the body, which have a very material influence on the viscera contained in them. Dr. Little's essay will point out the great influence which an insufficient expansion of the chest in infancy has upon the shape of its walls, by exposing the bones to atmospheric pressure. Much more powerfully will this force act when the bones are softened even beyond what is natural in infancy. Hence one of the causes of deformity of the chest in rickets may be conceded to be the pressure of the atmosphere upon the softened bones, induced by incomplete expansion of the chest, the result of laryngismus stridulus, or of collapse of the lung-tissue—common affections in weakly children. A second cause is the outward pressure on the lower ribs, caused by enlargement of the liver and spleen, often present in these cases;¹ and a third (which seems rather theoretically probable than absolutely proved) is the inward traction upon the cartilaginous extremities of the ribs by the attachments of the diaphragm. The result is a constriction of the chest, much as though a string had been tied tight round it below the heart, whilst its apex is distended. Except in very severe cases, this deformity of the chest may be expected to be effaced as the child recovers from the constitutional taint.

The pelvis is often the seat of deformity, whereby its outlet is much narrowed, the tuberosities of the ischia being pressed towards each other, and the pubic arch widened; or else the face of the pelvis is pressed backwards towards its posterior wall, the tuberosities of the ischia are thrust outwards, and the pubic arch widened.² In some cases, again, the whole pelvis is said to retain the small size and imperfect development of infancy. Any of these deformities will of course oppose a serious, and perhaps insuperable, obstacle to parturition in after life; and the change of shape of the outlet is often a source of embarrassment in lithotomy in children. This embarrassment, however, seldom proves serious; but a case is on record in which the operator was obliged to abandon the attempt to reach the bladder on this account, although a renewed attempt was more successful.³

The existence of a constitutional cachexia is proved in some cases by an interval of languor and general ill-health preceding the appearance of any disease in the bones; but very generally the latter symptoms are the first which attract attention. The disease commonly begins before the age of two years, although often earlier, and even in intra-uterine life, forming one of the causes of congenital fracture. The child, if it has been able to walk, loses that power; if it has not, it does not make the usual efforts to 'find its feet.' It loses the activity both of mind and body which is natural to early life, and its muscular strength diminishes. Enlargement of the ends of the long bones where the shaft joins the epiphysis, and of the ribs where they join their cartilages, is early noticed; and soon the fact of the bones being softened is proved by their yielding to mechanical force and becoming distorted. The enlargement of the joint-ends is most perceptible at the wrist and ankle, especially the former, on account of the superficial position of the bones; and therefore the swollen state of the ends of the radius and ulna, together with that of the ribs, is the familiar test of the existence of the disease: but dissection proves that the same condition exists in the deeper-seated bones. It must not be forgotten that a slight enlargement at this part of the bones is natural in very early life.

There are some other symptoms which, although they are not essentials of the disease, nor can be relied on to diagnose it in the absence of the affection of the bones, yet are very constantly met with in rickets. These are retarded dentition, retarded closure of the fontanelle, enlargement of the head, sweating of the scalp, and a tendency to throw off the bedclothes at night. Muscular weakness is also generally a prominent symptom, even beyond what the softened condition of the skeleton would account for. The assemblage of such symptoms would lead to the suspicion of impending or commencing rickets, and would justify prophylactic treatment founded on such suspicion; but the enlargement of the ends of the bones with softening of their shafts is the only diagnostic mark of the actual presence of the disease. Reference must again be made to the following section, by Dr. Little (pp. 815 et seq.), for a description of the arrest of growth and development connected with rickets.

The ætiology of rickets is a subject on which much interesting discussion has lately been raised, more especially from the striking researches of M. Parrot, and the very valuable preparations which he has preserved in illustration of those researches. He has taught broadly that rickets is one of the forms of congenital syphilis—a view from which I entirely dissent, and which seems to me in flagrant contradiction to the experience of every-day practice (see p. 806). But I am far from denying that a close connection may and does exist between rickets and syphilis. In fact I regard rickets as a disease of mal-nutrition, very possibly engrafted on an original predisposition or diathesis,⁴ but caused, in the sense of being excited, by such ordinary and universal causes of mal-nutrition as want of breast-milk, improper feed-

¹ On the enlargement of the viscera in rickets see an interesting paper by Dr. Dickinson, *Med.-Chir. Trans.* vol. lii. The author shows that the enlargement is due to a different deposit from that of lardaceous or amyloid degeneration—that it bears some analogy to the affection of the bones, and that it rapidly disappears as the disease yields to treatment.

² Humphry, *On the Skeleton*, p. 447.

³ Sir H. Thompson, in *Med.-Chir. Proc.* Nov. 24, 1863.

⁴ See the lectures on Diatheses lately delivered by Mr. Hutchinson at the College of Surgeons.

ing, bad air, and all the other ills of poverty. This view is, I think, the one generally adopted in this country, as being on the whole that which is most consonant with all that is known both of the symptoms and the pathological anatomy of the disease. In support of this view it has been alleged by some experimenters that rickets can be artificially produced in the lower animals by an improper diet, and it seems certain that some affection can be so caused which, if not identical with human rickets, at any rate greatly resembles it.¹ Again, it has been urged as showing the dependence of the disease on mal-nutrition that it is far more common among the children of the poor, and of these it prevails far more amongst those who are poorest.² Another fact which seems to show the dependence of rickets on mal-nutrition is its excessive prevalence among the ill-fed, ill-clothed, ill-cared-for, and ill-housed children who inhabit the crowded streets and alleys of our great cities, while in foreign climates, where the poor children, though perhaps of weaker stamina originally, yet are fed exclusively on breast-milk and live for the most part in the open air and under a genial sun, it is hardly known.³ Nay, even in the United States, where the children do not differ much in race from our own, and the habits of life are somewhat similar, yet, apparently from the better condition of their houses and the greater abundance of wholesome food, they suffer much less than in this country.⁴ All these facts, to which others might easily be added did space permit, seem hardly to be reconcilable with any other conclusion, which indeed is the only one in harmony with the general clinical features of the disease, that rickets is essentially a disease of mal-nutrition. Such a view by no means excludes the idea that syphilis may be one of the conditions productive of such mal-nutrition, for we know how powerfully the influence of congenital syphilis is shown on the miserable wasted infants who present themselves in our out-patient rooms. The views of different observers differ as to the share which is taken by each of the factors enumerated in the production of rickets. Most ascribe the origin of the disease in the greatest measure to bad feeding—*i.e.* to the want of breast-milk, or to its poor quality. Dr. Baxter, in the debate above quoted, laid much stress upon starch feeding, and Mr. Morgan seems inclined to agree with him. My own impression is that all the elements of mal-nutrition combine to produce the disease in a proportion which varies for different cases and which it is practically impossible to settle; and I think it very probable that syphilitic children may succumb to these evil influences more readily than others without its being necessary to assume any specific connection between rickets and syphilis. It is an old doctrine that the later children of large families are more liable to rickets than the earlier ones; but Mr. Morgan's researches hardly bear out the idea.

It remains to speak of the treatment of rickets and of those permanent deformities which are left by rickets.⁵—T. H.

The etymology of the word would lead to the supposition that it was applicable to diseases or deformities of the spine (*ῥάχης*) of all various kinds. But by common usage it is now exclusively employed to denote a particular disease of the osseous system, in which not only the spine, but the bones of the skeleton generally, and often the teeth and some other systems, are affected. However, the meaning of the name would appear to have had some influence in causing the opinion to be long entertained that the curves in scoliosis or lateral curvature were dependent on a morbid change in the bones, allied in its nature more or less intimately to that in rickets. But as females are peculiarly prone to be affected with lateral curvature, and as a deformed and contracted condition of the pelvis, especially dangerous in child-birth, is a common consequence of the softening of the bones characteristic of rickets, it is important to determine whether there be any foundation for the opinion. And numerous reasons are opposed to it.

1. Rickets is essentially a disease to which children of early age are subject; but the ordinary period of life at which scoliosis begins is from ten to fourteen. 2. The female is somewhat more frequently affected; according to Guérin in the proportion of 198 to 148.⁶ 3. Rickets is most prevalent in the poor; lateral curvature in the well-to-do classes. 4. Rickets is a positive disease; in lateral curvature the health is not necessarily disturbed. 5. In rickets the bones of all the body, some more, some less, are either incurvated, or they and the system

¹ A disease believed to be identical with rickets was produced in puppies by improper feeding (Dick, *Path. Soc. Trans.* vol. xiv. p. 289), and this is confirmed by M. Jules Guérin, *Trans. Internat. Med. Congress*, 1881; *Diseases of Children*, p. 52.

² Mr. J. H. Morgan, in an interesting paper entitled 'Contribution to the *Ætiology of Rickets*,' *Med. Times and Gazette*, June 24, 1882, thus sums up an inquiry into the circumstances of 150 cases of rickets: 'More than half came under the heading of "very poor," and among these it might be supposed that the nourishment given to a young child would be scanty in quantity and inferior in quality. The second class of "poor," or those who were better off than the last, but in far from good circumstances, included almost the remainder of my cases; only five coming under the heading of "fair circumstances," the best of the three classes.'

³ See the reports of various Indian surgeons quoted by Mr. Spencer Watson in the discussion on Rickets, *Path. Soc. Trans.* vol. xxxii. p. 380.

⁴ See Dr. Meigs and Dr. Pepper of Philadelphia, as quoted by Mr. Watson, *ibid.* p. 381.

⁵ The remainder of this section is from the pen of Dr. Little. The topic of Lateral Curvature, which was treated here in former editions of this work, has now been transferred to the essay on DISEASES OF THE SPINE, in vol. ii.

⁶ Since the times of Portal (*Observations sur la nature et le traitement du Rachitisme*, Paris, 1797, German translation, Leipzig, 1798. *Considérations sur la nature et le traitement des Maladies de Famille*, Paris, 1814), Bichat, and Stanley (*Med.-Chir. Trans.* vol. vii. 1816) to those of Shaw, no observer had contributed so much to the pathology and symptoms of rickets as Jules Guérin in his *Mémoire sur les caractères généraux du Rachitisme*. Paris, 1839.

at large show some other indication of a generally prevailing disorder; the spine and ribs are included, but so are the bones of the lower extremities, and the latter are commonly much more distorted than the spine: in lateral curvature, on the contrary, the spine is incurvated and the ribs distorted only as a consequence of the spine being curved, whence the spine is really the only part primarily curved, the rest of the skeleton being normal.

There remains another diagnostic sign. It relates to certain distinctions in the configuration of the adult frame. But to be understood, some preliminary explanation is required.

Rickets, it has just been stated, is a disease of early childhood. The usual period of its attack and duration is between one and five years of age, less frequently discovered during the first year. It varies in its severity, as well as duration, in different cases; but its most general characters are—visceral derangement, with impaired nutrition, inflammatory degeneration of the structures of the bones, chiefly marked by deficiency in the quantity of hardening material, and more or less distortion of the skeleton consequent on it.

There are two particular periods of life during which growth is more rapid than at any other period—namely, during the first year, in order that the child may be fitted for locomotion, and from the tenth or twelfth year to the fourteenth or seventeenth year, to fit the individual for the independent duties of life. The first of these periods alone is that in which rickets originates, except the case has been congenital. Rickets is often hereditary, or the individual is born with a predisposition to the disease on the application of unsanitary influences, such as want of breast-milk, &c. Congenital rickets has been attributed to defective nutrition of the infant, but this explanation will not apply in the case of twins, when one foetus was rachitic and the other free from it.¹ Rickets may be either very acute or less severe—the first accompanied with much acute constitutional disorder, the second occurring insidiously in a previously healthy infant.

We are chiefly indebted to Jules Guérin for our modern knowledge of the morbid anatomy of the complaint. He showed that the essential change in the bones consists of the substitution of a thin rose-coloured gelatinous sanguineous material for the bony matter both between the periosteum and the outer case, as well as between the interior of the bone and the lining membrane of the medullary canal and between the epiphysis and the diaphysis, the bone readily bending or breaking on the application of slight force.

It has well-marked stages—the incubatory or initiatory, the phenomenal stage of bone softening, and the subsequent stage of hardening or ‘eburnation.’ The last stage is reached before the age of five years, and is completed more or less quickly afterwards.

The theory of a lactic or oxalic acid diathesis has been advanced to account for the disease, and the use of earthy phosphates and carbonates has been recommended in accordance with the theory. Experience shows, however, that the stage of eburnation is reached, when the individual is not carried off by intercurrent brain, chest, or abdominal disease, whether or not the above ingredients and cod-liver oil have been administered. We do not deny the value of this oil as a nutritive agent.

During the morbid process the individual is stunted in length, the arrest being manifested in the long bones, particularly in those of the lower extremities, for reasons hereafter stated. Ultimately the bones may be found disproportionately thick and of high specific gravity. They become curved from the action of the muscles and from the influence of gravity.

The symptoms of the acute form are acute constitutional disorder, feverishness, looseness of bowels, undue perspiration and hectic, night sweats, wasting restlessness, cries, morbid sensibility to touch; tumid belly, sometimes soft as if from fluid contents, at other times firm and large: palpation and percussion, indicating that the liver and sometimes the spleen is swollen. Often white stools occur without jaundice. In both acute and mild cases nodes are seen at the junction of the ribs with their cartilages, and on the wrists and ankles. The softening of the ribs may reach a degree which greatly interferes with their function during respiration; hence the lungs, heart, and vascular system are much disturbed, sudden death resulting as from turning a child over for the purpose of auscultation.² As a rule the rickety child fortunately exhibits considerable tenacity of life.

Deep creases in the integuments, as in the internal and upper part of the thighs, indicate bent bones beneath. The dermoid system is visibly affected, as shown by morbid hairiness of some parts, by slow evolution of the first set of teeth, by their being often shed unduly early, and by the marks upon the second set showing imperfect formation of dentine and enamel. Holmes says, ‘As in syphilis, cancer, and scrofula, the local condition is in rickets only the expression of a latent tendency in the whole organism which attacks other parts as well as the bones’ (see p. 813).

The majority of writers on rickets include in this disease many cases of joint distortion in which the patients are free from rickets (see vol. ii. p. 260). We have eliminated from rickets all cases of atonic, commonly called statical, genu valgum, just as Shaw and Guérin forty years ago showed that ordinary scoliosis is as a rule not a rachitic affection. The error of having included in rickets the atonic forms of knock-knee seriously vitiated the conclusions arrived at by many who took part in the discussion on rickets (1880) at the Pathological Society. This error shows how apt rickets is to be mixed up with other forms of disease. In the last century physicians believed in the existence of ten forms of rachitis, the principal of these being

¹ Johannes H. Klein, *Casus Rachitidis Congenitæ Observatæ*, 1763.

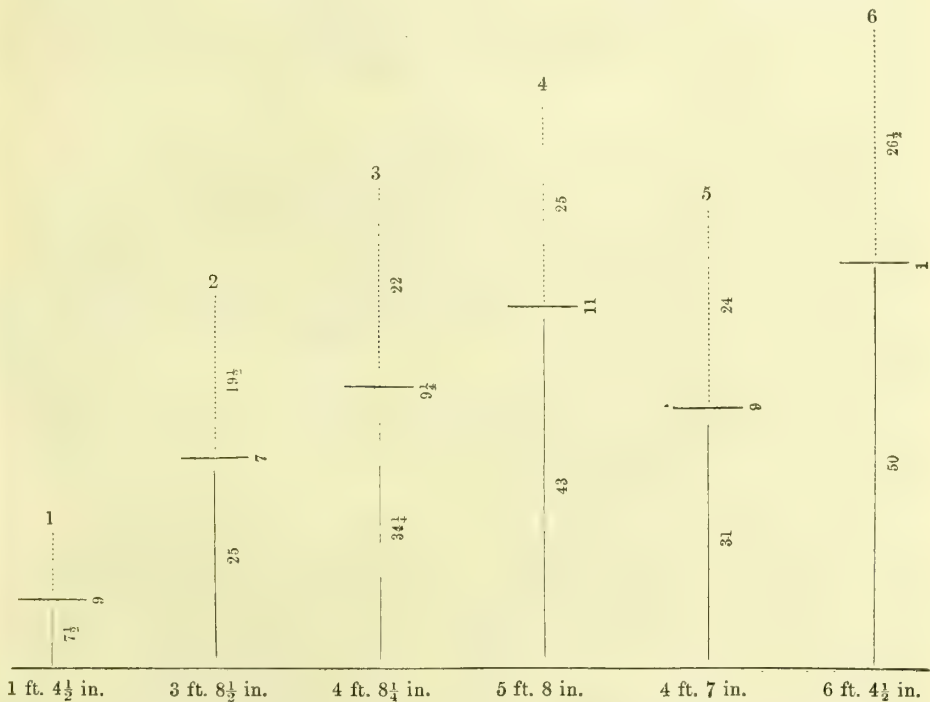
² See Dr. Dickinson, *Path. Trans.* vol. xix. p. 323.

true rickets, the syphilitic form, the tuberculous form (Pott's disease), the scorbutic form, and osteo-malacia. The last is not even at present thoroughly distinguished from it. It is still undecided what is the difference, chemically and microscopically, between it and other forms of bone softening. Clinically true rickets is the only disease that proceeds to 'eburnation,' with *arrested* growth as to length, *increased* growth, as to width increased density (even double the normal weight), and reaching the final stage about the age of five years¹ and never returning after that age, *distortion* however remaining, which may even increase from statical causes.

Osteo-malacia differs from rickets by its practical incurability. The fractures may temporarily heal and the distortions produced by osteo-malacia may be straightened, but the constitutional condition appears permanent. We watched a case from the age of thirteen to twenty-three; the only change we witnessed was that the fractures were less frequent after full growth.

Fractures of the green-stick variety are common in rickety infants, and, as Holmes states, 'generally unite kindly.' It may be added that in rachitic fractures the young surgeon should not expect always to feel crepitus.

FIG. 207.—No. 1, relative proportions of Upper and Lower Divisions of Child near Birth. The upper dotted line, in all, gives the length from vertex of head to crest of ilium; the lower bold line, from crest of ilium to ground; and the transverse line, the breadth of the pelvis. No. 2, at eight years of age. No. 3, seventeen years. No. 4, adult. No. 5, adult, stunted by rickets. No. 6, person of lofty stature.



The measurements were taken according to a scale of $\frac{1}{32}$ th of an inch to one inch. The above proportional measures should not be considered as of universal application to individuals. Thus we find in a well-proportioned elderly male adult, without shoes, now before us, whose height is five feet ten inches, that the lower portion measures 42 inches, and the upper portion 28 inches. In another young adult, measuring five feet eleven inches, the lower portion amounts to 44 inches, and the upper 27 inches. The elder person has probably lost some portion of the former youthful length of the trunk and of the lower extremities owing to increased horizontal situation of the neck of the femur, whereas the young man has not yet completed the growth of the trunk.

When the disease has run its course, within a period perhaps of one or two years, the patient will be restored to health, but the deformity will remain; and he may bear the marks of rickets all his life in the teeth or in the incurvation of the principal long bones. After, however, his growth has been completed and he has arrived at adolescence, an additional and different kind of change in his figure will be perceived.

To understand this subject, it is required, first, to keep in view the distinction which exists in the general conformation of the infant's frame, as contrasted with that of the grown-up person; and secondly, to consider what effects will be produced upon the figure from the morbid arrest of growth in rickets.

In the sequel it will be seen that the inquiry embraces the form of the head, as well as the proportions of the whole body. When considering the latter, which may be taken first, it

¹ Several authors have stated that in foetal rickets the whole of the stages have been traversed before birth.

will be convenient to distinguish the upper division, consisting of the head, the trunk (down to the pelvis), and the upper extremities, from the lower, consisting of the pelvis and inferior extremities.

On comparing the form of the infant's frame with that of the adult, it will be perceived that the conformation of the former has relation to the act of parturition; while that of the latter has relation to man's erect position and his locomotion by means of the lower extremities. The adaptation of the figure of the fœtus to the process of delivery is exhibited at an early period of gestation. It is owing to the head of the young embryo being preponderatingly large compared with the nether extremity, and to the short and thick umbilical cord being attached to the smaller end, that the head falls into its place, from the beginning, over the orifice of the uterus, as it has to be expelled eventually the first. Again, while the bones of the trunk and arms during foetal life enlarge at about an equal rate, the pelvis and attached members are kept in check, and are relatively small at the period of birth—a provision obviously designed to prevent the circulation in the umbilical cord from being stopped by pressure, which would occur if the pelvis were large, and blocked up the pelvic canal of the mother after the head had been delivered. But the newly-born infant, with its bulky upper and diminutive lower quarters, is incapable of using its feet either to walk or stand, and it must later on creep on all-fours. The rapid growth which we have shown takes place during the first year, and proportionately great development of the lower extremities, fits the infant for locomotion at the end of the first year. We have also shown (p. 816) how relatively active is the growth of the limbs on the approach of puberty. The proportions of the frame are reversed in the adult. The upper division—head, arms, chest, and abdomen—are small, light, and easily carried; while the lower division—the pelvis and lower extremities—are massive, strong, and calculated for supporting and transporting the superstructure.

If it now be supposed that, while the childish frame is passing through this revolution in its proportions, in accommodation to new conditions, rickets should intervene, causing a temporary interruption of the growth, it is obvious that the stoppage will have the effect—as will be seen at adolescence—not only of stunting the individual in size, but of marring the proportions of his figure by interfering with the fulfilment of the changes which ought to be wrought in the relative dimensions of the members of his body. He will present, when arrived at manhood, some of the appearances characteristic of childhood. Accordingly, the person of an adult rickety individual is observed to be diminutive throughout; his stature is short, even allowing for the loss of height from the incurvation of his bones; he has been seen of half the average height; his head is large, the trunk also is large, but the hips are narrow and the legs short.

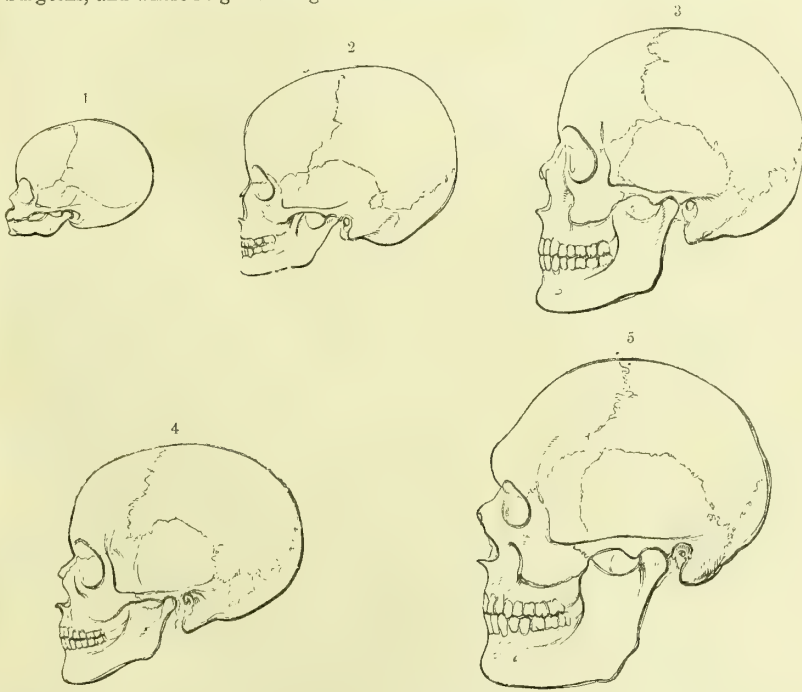
And the converse of what has been stated is true. If the growth of the non-rachitic frame has been over-active, so that the natural changes have been carried to excess, as witnessed in uncommonly tall individuals, the proportions of the adult will be brought out to an exaggerated degree. The upper division—head, chest, abdomen, spine—will be relatively small, short, and light; while the lower—pelvis and lower limbs—will be inordinately broad, massive, and long.

In the head, as intimated above, analogous changes in the relative dimensions of the cranial and facial divisions, occurring between birth and adolescence, may be observed; and they are subject to be modified by differences in the rate of growth in the same manner as in the whole frame. The peculiarity which principally characterises the form of the child's head, apart from the fat chubbiness of the cheeks, is the small, contracted size of the face contrasted with the capaciousness of the cranium. Now, the subsequent increase of each of these two divisions is regulated by a distinct and appropriate influence. That which determines the growth of the cranium is the development of the brain; this important organ is distinguished for the early period of life at which it arrives at perfection; it has nearly attained its full size about seven years of age, and its increase subsequently is so slow and slight that its development may be said virtually to cease about fourteen. As the cranium therefore grows *pari passu* with its contents, it comes to maturity at the same speedy rate. The case, however, is different with the facial division. The influence which guides its growth is the development of the organ of mastication in particular. The toothless gums of the infant are adapted to the mode of its being fed by suckling. But in proportion as the two sets of teeth emerge in succession, the jaws, which had been remarkably small at first, commence to enlarge, and they go on progressively increasing till they become relatively of great magnitude. And it is not the maxillæ alone which grow in conformity with the teeth; the adjoining processes and surfaces, from which the powerful muscles that move the lower jaw take their origin, consentaneously enlarge. Again, this active course of development in the facial division is continued for many years after that in the cranial has come to a standstill: it does not stop still at adolescence; steadily, the former has been making advances, in point of dimensions, upon the latter. It is accordingly found that the facial division in the adult has a much larger relative size than in the child. But if it be supposed that, while that change is being effected, a stoppage of the growth for a considerable period, as by rickets, should intervene, it is obvious that the part which ought to make the greatest progress will appear to suffer most. Hence the facial division is always observed, in the individual affected with rickets, to be relatively smaller than the cranial; so that while the latter seems of average natural size, the expansion of the cranium, owing to its being composed of a number of sepa-

rate bones having necessarily kept pace with the enlargement of the brain within, the jaws, both upper and lower, are peculiarly diminutive, and the prominences of the face corresponding to the frontal sinuses and cells of Highmore are imperfectly expanded. And here it may be noticed, in reference to this contrast, that the forehead is particularly prominent and appears remarkably capacious in most persons deformed by rickets; but the evidence of the callipers will show that no real enlargement of the cranium exists, and it will be concluded that the prominence and expansion of the frontal region only appear great because the face in juxtaposition is abnormally little.

Let it be supposed, on the other hand, that the rate of growth has been accelerated in a non-rachitic individual, it may be expected that the relative proportions of the two divisions of the head will be the reverse of those seen in the head of the rickety one. As the configuration of the latter bore distinct traces in the large cranium and small face of the pristine form of the child, the configuration in a person whose growth has been carried on at an ultra-rapid speed—as, for example, in an individual of gigantic height—will present the signs of the adult form in an exaggerated degree. The principal additions will be observed in the facial division; the upper and lower jaws will be greatly enlarged; the cellular compartments in the bones of the face, which, at the same time that they are appendages of the vocal organ, contribute large surfaces exteriorly for the attachment of muscles, will be expanded; and the result will be that while the cranial division has remained relatively stationary and small, the facial will have acquired extraordinary bulk. Further, it will be perceived that the frontal region, instead of being

FIG. 208.—No. 1, Skull of Infant at Birth. No. 2, Skull at about Six years of age. No. 3, normal Adult Skull. No. 4, Skull of Adult Rickety Person. No. 5, Skull of Byrne, whose skeleton is in the College of Surgeons, and whose height was eight feet.



broad and prominent, as in the rickety skull, will appear shelving and low. That condition, however, is a consequence merely of inordinate increase in the size and expansion of the frontal sinuses.

As the frontal sinuses assist in modifying the form of the forehead, they have a remarkable influence also, in common with their allied cavities in the upper maxillary bones—the cells of Highmore—of keeping the orbits (both of persons in whom the growth has been interrupted and in whom it has been over-active) of a uniform size. When the eyeball, the chief occupant of the orbit, has completed its growth, at a comparatively early age, the other contents likewise attain their full size, and they do not vary in bulk afterwards; hence the cavity may continue of the same dimensions throughout life. Now it is found that orbits, thus adapted to their contents, remain constant in capacity, equally in skulls distinguished for their smallness and for the great magnitude of their facial divisions. To verify this, Mr. Alexander Shaw made measurements of the orbits in a numerous set of skulls, which differed from each other in the relative dimensions of the bones of the face, according to the diversity of the rate of growth. These measurements were taken along the lines of the several diameters, longitudinal, transverse, and antero-posterior; and the results showed that their lengths were the same, with scarcely any appreciable difference, in all the skulls. The explanation of the uniformity is obviously as follows. The frontal cells are situated over, and the maxillary cells under, the orbits; so that

the floor of the former is the roof, and the roof of the latter the floor, of the respective orbits. Again, these cells are either imperfectly developed or developed to a great extent, according as the growth of the individual has been below or above the average rate. Being of diminutive capacity in the skulls of persons stunted in their growth during childhood—as in rickety individuals—the cells occupy a small space above and below the orbits, and the cavities of the latter therefore retain the standard dimensions; but being, on the other hand, of large capacity in the skulls of persons whose growth has been abnormally active, as in tall overgrown individuals, the cells encroach, as it were, by their magnitude on the walls of the orbital cavities, and subdue them to the standard dimensions.

Reverting now to the subject of diagnosis, and the question whether scoliosis depends on a morbid condition of the osseous system identical with or analogous to rickets for its origin, it may be alleged that the opinion derives no support from the preceding observations. Evidence is altogether wanting to show that, while in scoliosis the curvatures of the spine—which are the only apparent effects of the supposed softening of the bones—are in the course of forming, there is any arrest of the general growth like that which takes place in the deformity from rickets. Independently of the changes consequent on the incurvations of the spine, the relative proportions of the figure are natural; the lower extremities are developed to their full extent in length, breadth, and weight, and in the head there is a proportion between the cranial and facial divisions.

What chiefly makes it important to decide the question whether lateral curvature really depends on a softening of the bones, such as that to which rickets gives rise, is the consideration of the condition of the pelvis in a female patient. When rickets invades the osseous system, the most formidable effect it produces is deformity of the pelvis, the circle of bones through which the child is propelled in the act of parturition. But it has been formerly stated that, among persons affected with lateral curvature, the proportion of females so greatly exceeds that of males that the deformity might be regarded as almost peculiar to women. Accordingly, if lateral curvature be supposed to be a consequence of rickets, the inference will be drawn that all female patients so deformed will have been exposed to the danger of having their pelvis also deformed.

In his work on 'Distortions of the Spine,' Mr. John Shaw opposed the view that rickets had any share in causing lateral curvature. And he stated his opinion, founded on the examination of numerous specimens of distortion preserved in different collections, that the pelvis would not be found deformed unless there were evident signs of the bones of the lower extremities, especially the tibiæ and fibulæ, which bear the greater amount of the pressure of the superincumbent weight, having become incurvated.

But the preceding observations have shown that although degeneration and softening of the osseous system, with consequent incurvation of the long bones in particular, are prominently marked features of rickets, yet that they are not the only important ones which characterise it or bear upon the question of the condition of the pelvis. It has been seen that, owing to rickets being a disease of childhood, and its checking or stopping the growth, it prevents that change in the relative proportions of the frame by which the figure of the child, independently of bulk or stature, is distinguished from the figure of the adult, from being fully carried out. Now the interruption tells with especial effect on the pelvis. No part in all the skeleton undergoes such a great transition, from being relatively small to being relatively large between the two epochs of infancy and adolescence, as that girdle of bones in the female. When the growth, therefore, is arrested, it is to be expected that the pelvis will be diminished in bulk throughout its whole extent, in proportion to the rapid rate at which it would have increased but for the stoppage. Accordingly, by measuring several pelves of skeletons deformed from rickets, and others of sound structure, and then comparing them, Mr. A. Shaw ascertained that the number which represented the average of the united measurements in the rickety pelves was five and a half, while that representing the normal pelves was seven. And the inferiority of the pelves deformed from rickets in their general dimensions shown by the above numbers was manifested likewise, as might have been anticipated, in the pelvic canal, the diameters of which, both at the inlet and outlet, were correspondingly narrow.

Hence it may be perceived that when a patient affected by rickets in childhood has reached womanhood, and is in child-birth, she is subject to difficult labour from two distinct conditions of the pelvis—namely, irregular contraction of the pelvic canal, from the softening and deformity of its walls; 2, narrowness of the canal, from defective growth of the walls.¹

PIGEON-BREAST DEFORMITY.—This distortion consists in a protuberance of the sternum and cartilages, by which the antero-posterior diameter of the chest is disproportionately enlarged, and a gibbosity produced. Corresponding to the line of junction of the cartilages to the ribs, a sulcus on each side forms a boundary to the projection. The deformity is not inconsistent with symmetry in other parts of the chest and the frame generally. It is equally common in both sexes. When confirmed, the heart and lungs are somewhat altered in relative position in adaptation to the figure; but their actions are not perceptibly deranged.

¹ Patients deformed from rickets, and in whom the pelvis is really narrow, are often noticed to be broad across the hips. That appearance is due to the head of the femur being sunk below its proper level, and the trochanter major relatively elevated, and there is commonly combined an arching outwardly of the upper portion of the thigh-bone. See two papers on Rickets by Mr. Alexander Shaw—the original writer of this article, and whose valuable anatomical description of the effects of rickets upon the head, face, and pelvis we have retained—*Med.-Chir. Trans.* vols. xvii. and xxvi.; also others on the same subject in the *London Med. Gaz.* for 1835, pp. 45, 349.

The deformity is more frequently observed in the young, from six to twelve years of age, than in adults; which leads to the inference that patients commonly outgrow it.

Causes of the production of pigeon-breast.—A view that appears to solve the problem suggested itself to Mr. Shaw when observing the movements of the chest in a child labouring under dyspnoea with impending suffocation, and for which tracheotomy had to be performed. The patient had previously a flat chest of ordinary shape. By the stethoscope it was ascertained that scarcely any air entered the lungs. What chiefly attracted notice was the imperfect manner in which the thorax underwent expansion at each act of difficult inspiration. The clavicular and upper sternal regions were protuberant and fixed; the respiratory movements were confined to the lower three-fourths of the thorax. But, instead of the ribs which moved dilating to their full extent when inspiring, their sternal ends were drawn inward. And as that sinking took place along the line of junction of the costal cartilages with the ribs, from the third or fourth downward, and chiefly near the lower margins of the chest, a depression of the antero-lateral regions was the result. Now the appearance thus presented resembled so greatly the falling-in of the ribs and protrusion of the sternum seen in pigeon-breast deformity that the conditions seem identical. The constriction disappears at each act of expiration. Thus, contrary to normal breathing, a partial contraction of the thorax occurred at every inspiration and a partial expansion at every expiration. Similar phenomena have been frequently observed since; we have seen it in acute rachitis.

Taking into view the great flexibility of the walls of the chest in childhood, it may be understood how they should be subject to imperfect expansion in the manner described above when the air, *through any cause*, is prevented from fully distending the lungs. In the act of inspiration two distinct operations are performed—first, to create a tendency for a vacuum, the thorax is expanded; next, the weight of the atmosphere causes air to enter the lungs.

By the free admission of that air into the interior a balance is established between the pressure of the atmosphere on the outside, and that on the inside, of the chest; consequently, although the parietes may be thin and pliant, their movements can be performed with perfect facility. But quite a different state may be expected when the expansion of the chest is unaccompanied with a corresponding dilatation of the lungs. For example, in the case of a child whose larynx is so much closed as to impede the entrance of air, it is obvious that, if the thoracic walls could be expanded, there would be nothing to counterbalance the weight of the atmosphere without. In such cases the chest is incapable of being expanded or it is expanded imperfectly. To the best of their ability the intercostal and external accessory layer of respiratory muscles elevate and widen the area included within the sphere of the ribs; the diaphragm also acts on the free margin of the chest, downward and concentrically, to increase the vertical diameter; but the pressure of the atmosphere interferes with their effect. And that pressure from without tells mostly on the weakest parts of the compages. These are, unquestionably, situated in the line of junction of the costal cartilages with the ends of the ribs, a part in which rachitic nodes and softening of texture invariably exist. Accordingly, it is there that the chest is principally indented; and this indentation leads to the sternum being abnormally protuberant.

Taking these observations into view, they show that when the chest, as in childhood, is highly flexible, any cause that obstructs the entrance of the air into the lungs may lead to changes in its figure resembling pigeon-breast deformity. In the example which has been given, the source of the difficult breathing was of a kind to threaten life. But it can be conceived that a cause acting in a similar manner, yet of relatively slight importance as regards health, might imperceptibly, and after a considerable lapse of time, bring about an identical condition of the chest. If a child suffer from chronic enlargement of the tonsils, the encroachment of the glands on the glottis may diminish the calibre of the tube to such a degree that the air will enter with difficulty, so as to fill the lungs incompletely; and the long continuance of the dyspnoea thus produced may lead eventually to the chest becoming of the pigeon-breast shape. This idea is supported by the fact that patients with this deformity are frequently found to have suffered at one time from enlarged tonsils. Mr. Alexander Shaw had under his care a boy three and a half years old, in whom both tonsils were so large that they gave rise to dyspnoea, aggravated at nights so as to threaten suffocation. The air entered the lungs imperfectly; and it was remarked that the front of the chest was gibbous. The glands were almost beyond sight, having been propelled downward, as it appeared, from getting within the grasp of the constrictors of the fauces. Some days after a partial excision, the patient nearly expired in a fit of suffocation, and was restored by tracheotomy. Subsequently the tonsils were effectually removed, and the patient perfectly recovered. It was then particularly noticed that the front of the chest subsided to its natural level, and that all appearance of deformity was effaced. Laryngismus stridulus, atelectasia, may act in a similar manner in producing pigeon-breast. Mr. Holmes (p. 814) mentions that the outward pressure exercised on the lower ribs by the enlarged liver and spleen common in rachitis may have a similar effect.

TREATMENT OF RACHITIS AND RACHITIC DEFORMITIES.—So long as any doubt as to the pathology of rickets is not removed, the successful treatment of the complaint will best be based upon experience and not upon theoretic notions on the exhibition of supposed chemical antidotes, such as carbonate of lime, soda, and iron, phosphoric acid, and phosphate of ammonia, and certain advertised ‘chemical foods.’ However, if evidence in individual cases of sour

secretions, as complained of by the nurse, either in the breath or the alvine secretions, is present, alkaline earth is admissible and may be especially beneficial as regards the too frequent looseness of the bowels. Harm may undoubtedly result to the infant from the protracted use of the much-advertised alkalies and alkaline earths for months and years.

In the instances in which the main exciting cause of the disease in a very young infant is deprivation of the mother's milk, immediate recourse if practicable should be had to a healthy wet nurse, but the majority of cases are presented to us when the infant has reached the age of sixteen to twenty months, before which a child is usually weaned and has acquired the habit of artificially feeding, and the time has arrived when a purely milk diet is not desirable. The child is fretful, insufficiently or inappropriately nourished, is either thin or perhaps loaded with soft watery fat, is eager for food; the appetite has in many cases never been so satisfied as to enable the child to pass several hours in the night in sleep uninterrupted by feeding. One result often is that the child consumes in each twenty-four hours a mixture of milk, water, sugar, beef-tea, and farinacea amounting often to four or five pints or more, urinates and perspires excessively at all times; the errors committed under this system of feeding are that the diet is too uniform for the age and too watery for any age. The poor mother of the humbler class who feeds her child, often too soon, with part of everything which she consumes herself, is at least as fortunate as those parents who too long restrict the child, who ought to be walking about, to the sameness of diet and excess of water. The excess of water gives unnecessary work to the renal and cutaneous systems, and probably favours the carrying off from the blood of some phosphatic, earthy, or adipose materials which would have been useful if retained in the system.

The child at one year old has reached an age when a more solid diet is desirable, when a moderate quantity, one to two ounces daily, of pounded or finely-minced red meat, chicken, white fish, eggs, besides whole wheaten bread or oatmeal, should be given; milk and water, or water as a beverage only at meal times, remembering that any great change in diet should be gradually entered upon. Cream or butter or cod-liver oil are excellent adjuncts. Tender green well-cooked vegetables, besides potatoes, should be given at the age when the child is weaned and is expected to walk. In many cases, removal from the air of the place where the malady made its appearance is of significant benefit. We have found the seaside, other things being equal as to drainage, aspect, soil, and house ventilation, rapidly improve cases in the most alarming constitutional stage. We have had children, of wealthy parents, with intense rachitism, brought for consultation in cold spring weather from the northern manufacturing towns, whom we have instantly despatched to the Kentish or Sussex seaside resorts, who have rallied in a remarkable manner in two or three months. We have had a rachitic child, aged sixteen months, brought to us on account of fractured femur through a fall off a bed three months before, the part remaining ununited and capable of being twisted almost in any direction. The application of suitable light wooden splints, with meat diet, the reduction of the liquid diet to one half, and the use of small doses of quinine and iron, cod-liver oil, and a few teaspoonfuls of orange wine daily, were followed by firm union and 'running alone' in less than three months.

Much may be done for the prevention of distortions by allowing the child to pass his time in a roomy department of the floor where no harm can happen to him, and to spend as little time as possible in the arms of the nurse or on the lap. The flat, carpeted, or blanketed smooth surface enables the child to exert more easily whatever muscular and locomotor power he possesses better than a billowy feather bed or an unequally compressed mattress. The nature of the child's clothing is not an immaterial circumstance, for any impediment the clothing offers to free movement of the limbs, or to the child turning himself over or rolling over is objectionable, and is apt to retard recovery. The beau ideal of a dress for the encouragement of infantine spontaneous gymnastic movements is one without petticoats or any unnecessary clothing material between the limbs, or apt to get in the way of their movement. A single reasonably thick knitted Garibaldi and knickerbockers for the summer wear, and the use of a double set during winter, suffice.

Much may also be done for the reduction of deformity by limiting the amount of exercise and by mechanical treatment. The simplest means of this kind consist of rubbing and *manipulation* of the slightly bent limbs, and by checking the undue standing and walking which the eager child after partial recovery wishes to indulge in. Very slight curvatures may disappear after full recovery of strength and exercise, probably owing to the normal action of the muscles favouring a return of the bones to their natural shape. In all degrees of curvature except the slightest, splints, wooden or metallic, are indispensable to remove existing deformity, and to prevent aggravation through walking. We find the lightest and simplest and most convenient to be straight wooden splints, hollowed from side to side, which, when padded, may be secured against the concavity of the limb by straps and buckles, or by light porous roller bandages. We have constantly straightened cases of moderate severity by such splints. Older and more severe cases may require suitable padded irons, especially when severe genu valgum coexists, even in children between the age of five and twelve, and sometimes fifteen, when the bones have lost the touch all feeling of elasticity. Even the surgeon should be careful not to use any forcible pressure; we have more than once unintentionally snapped the leg-bones, which gave the advantage of 'putting the part up' straight with help of the starch bandage and a strip or two of thin wood, and of procuring with the help of diet a strong straight limb in a few weeks.

Crooked limbs are often very materially straightened by the judicious use of light firm splints, always supposing that the case is presented to the surgeon before the stage of consolidation has arrived; for afterwards the use of splints can only do harm. At any rate, they exercise a most beneficial influence in opposing further deformity; and in cases where it is important to prevent the child from standing or walking, they may be so applied as to project below the foot, when they more effectually prevent locomotion than any attention of the nurse or mother could do, more especially among the poor, who have seldom the power of attending exclusively to one child. For these reasons splints are advisable in most cases of rickets where the bones appear still softened. They should be removed at night, and reapplied after the child has been washed in the morning. They should be carefully padded, and are best fixed by a long piece of the webbing which is sold by saddlers. On no account should splints be used longer than while the bones appear to be softening. After consolidation is effected, their pressure can do no good to the curved bones, while it will assuredly *cramp* the action of the muscles and impede the restoration of their power. In the slighter cases of rickets the deformity almost or altogether disappears as the child grows.

This is the result derived from experience in hundreds of instances.

Considerable curvatures of the kind have been recovered from, without deprivation of exercise sufficient to keep the muscles and joints in good development, the apparatus being discarded in the worst cases undertaken after one, or at most two years' use.

Having stated that pigeon-breast deformity exhibits a tendency to spontaneous cure, it may suffice to refer briefly to certain measures which have appeared to assist nature in her work. A light springed truss, like that worn for umbilical hernia, has in very severe cases been found useful, but the wearing of it is inconvenient, and it is liable to be displaced by children, especially when they employ themselves with athletic games. Rowing may, as Shaw says, be specially mentioned. The majority of cases require insistence upon active outdoor and indoor mechanical occupations, in preference to lounging about with books. Unfortunately, youths affected with constitutional weakness crowd into sedentary pursuits and professions, for which book pursuits are an excuse and a snare.

T. HOLMES.

W. J. LITTLE.

OSTEOTOMY AT THE HIP, KNEE, LEG-BONES, AND RADIUS.

AT p. 274, vol. ii., we have already alluded to the great addition to curative art in the case of A. deformities since Mayer's osteotomy operations, before and during 1852. In the last edition, to which we refer the reader, we gave some details of Mr. L. S. Little's case of osteotomy for the relief of severe rachitic curvature of leg-bones, accompanied with a slight degree of genu valgum. The case in question, both legs, was the first osteotomy case for relief of distortion performed in this country, and, like all previous osteotomies in Germany and America, was performed by means of open wound and the saw.

In 1867 (see the last edition of this work) he also, before the adoption of antiseptic precautions, divided with the saw, by open wound, the radius in each arm for severe paralytic contraction and curvature. The wounds healed favourably. The patient was thereby enabled to grasp a pen between the inner borders of the hand and direct its movements quickly over the paper by means of the muscles of the shoulder, and write very plainly. Subsequently Mr. Little introduced the chisel and mallet in lieu of the saw at the London Hospital,¹ in a case of bony knee-anchylosis, in which the wound, being almost subcutaneous, healed without suppuration, permitting immediate straightening of the limb; whilst Mr. W. Adams introduced almost subcutaneous division of the neck of the femur for hip-anchylosis with success, with little or no suppuration.

These successes have led the way to a more general use of osteotomy.

We bring together under this section some remarks on the different classes of cases in which osteotomy has been successfully performed, and the different modes of performing it now resorted to, and as to the manner in which in the least obvious cases it produces its results (see as to this head also 'Genu Valgum,' p. 825).

Aided by the adoption of the quasi-subcutaneous principle, and the beneficial influence of Lister's antiseptic dressing of wounds, osteotomy, as we surmised in a former edition, has thus become one of the most satisfactory operations of surgery. A danger associated with it is that of its being unnecessarily employed. A short and ready 'cut' to a goal has many attractions. Not the least of the anticipated advantages consists in the saving of time to the patients, especially in the case of adults (see p. 826). Subcutaneous osteotomy is a distinct advance in our art. The hopes entertained of the formation of a new joint at the hip have not commonly been realised, because the tendency of artificially moved hips, regarded as 'new joints,' has been to become, after a time, anchylosed in the improved position. It remains for post-mortem examination in the future to show what is the precise condition as to mobility or fixity, and the situation where the movement, if any existed, had taken place after osteotomy. Mr. Adams's reports show that the most successful of his hip osteotomies took place in cases where the joint had been contracted and fixed from rheumatism. Now these are precisely the cases in which the internal parts of the joint itself are less frequently *disorganised*, as compared with strumous cases and others in which internal and external suppuration at the hip occurs. The late Mr. Maunder's cases illustrated the same view. Our experience teaches us that many cases of hip contraction, regarded by able surgeons as cases of true anchylosis of the hip, in which, however, considerable and protracted suppuration had not occurred, which were probably not strumous, or connected with scarlatinal sequelæ, were, as asserted, probably rheumatic, but are not true (internal joint) anchylosis, but false anchylosis—i.e. probably in great part external to the joint. Now every surgeon will have discovered how great is the difficulty to effect motion in the hip and improvement in the relation of the flexed and inverted or everted femur, as the case may be, to the trunk. The reason of this difficulty, where the anchylosis is merely false, is, firstly, the resistance afforded by the long-continued fixed contracted position of all the structures concerned in health around the joint—viz. the muscular, ligamentous, and fascial structures—and, secondly, the natural, anatomical, and mechanical arrangement of the hip-joint, the pelvis and femur being very unfavourable to successful employment of mechanical force (see p. 268, vol. ii.)

MODE OF PERFORMING OSTEOTOMY AT THE HIP.—Mr. W. Adams uses a tenotomy knife a quarter of an inch in width mounted on a long handle, and a saw four and a half inches

¹ *Med.-Chir. Trans.* vol. liv. p. 247.

long and a quarter of an inch wide, the cutting portion of the saw being only the extreme inch and a half, the remainder being blunt and rounded. The knife is to be passed down to the neck of the thigh-bone, a little above the great trochanter, dividing freely the muscles and capsular ligament. The saw is now to be substituted for the knife, and the bone sawn through from before backwards in a line parallel with Poupart's ligament. The wound is then dressed, or a pad of lint and a splint applied.

As elsewhere mentioned, Mr. Maunder employed the chisel instead of the saw, following in other respects Mr. Adams's method. We consider that with Maunder's chisel-osteotome there is less chance of disturbing and irritating the soft parts.

We once attempted to pass a chain saw around the neck of the femur, but were foiled. We might have succeeded below the trochanter. The femur has been successfully divided by several surgeons immediately below the trochanter, both by saw, drilling, and chisel.

OSTEOTOMY FOR THE CURE OF GENU VALGUM.¹—This operation at the knee has been performed from two points of view—the one based upon the belief that in knock-knee the internal condyle is unduly long, the other on the observed fact that genu valgum is often combined with curvature of both femur and tibia. We have endeavoured (vol. ii. p. 260 *et seq.*) to show that a large proportion, if not the majority, of knock-knee cases arise from atonic causes affecting the fibrous structures concerned in the knee-joint, and that the smaller number arise from softening and deformity of the bones. We have also shown that the anatomical results are deterioration and deficiency of the external condyle, and of the opposing external articular surface of the tibia, especially in the atonic or non-rachitic cases, whilst in the rachitic cases curvature of the femur and tibia habitually co-exist. Now it will be seen that in the greater number of osteotomy procedures the first object has been to lessen the length of the internal condyle, and thus remove the apparent obstacle to straightening created by the morbid changes in the form of the articulating surfaces. A second object has been to remove so much of the deformity as is due to curvature of the shafts of the long bones by division of them. It does not appear that any of the surgeons who have distinguished themselves by the success of their osteotomy operations have discovered any distinction between the non-rachitic and the rachitic cases. We have already written sufficient to show that in our opinion many unnecessary osteotomy operations for genu valgum have consequently been performed.

Ogston's operation.—Dr. Ogston of Aberdeen passes a long tenotome through the skin above the inner condyle in front of the bone and into the joint towards the inner side of the crucial ligaments, dividing all the soft parts between the knife and the bone. An Adams's saw is then substituted for the knife and the condyle sawn off from before backwards. The limb is then straightened (not without the application of some force) and placed in suitable immovable apparatus.

Reeves's operation is a modification of that of Ogston, substituting the chisel for the saw, and stopping short in its use at the inner surface of the articular cartilage. It is obvious that in this operation, if only rigid, aged, or inveterate cases be selected for operation, some degree of abrupt force, as opposed to gentle gradual force, requires to be applied to straighten the limb. It is claimed for this method, which is called by its originator 'subcutaneous extra-articular osteotomy,' that the joint is not opened, and that even should this occur, no debris are left in the cavity. It is, however, doubtful in many cases whether the first of these ends is attained.

Mr. Barwell's plan consists of two steps—first, the external third of the femur is divided just above the epiphysial line, and the limit then partially straightened by rupturing the remainder of the partially severed bone. When the gap in the bone thus formed has filled up, the tibia is divided transversely and the fibula obliquely about one inch below the joint.

Dr. MacEwen of Glasgow, in the supra-condylar operation, profiting by the experience of his predecessors, has in our opinion greatly simplified the above methods. He employs the usual anæsthetic, antiseptic, and bloodless precautions. Having laid the limb on its outer side, on a pillow of moist sand, he passes a scalpel directly to the bone at the point of intersection of a line 'drawn transversely a finger's breadth above the superior tip of the external condyle, and a longitudinal one drawn half an inch in front of the adductor magnus tendon.' A sufficient longitudinal incision is made (one inch or more), and a stout 'osteotome' passed down to the bone; this is then turned through a quarter circle, and by a few blows with the mallet made to penetrate the bone for about half or one-third its thickness; a finer instrument is then introduced, to be followed in some cases by a third, finer still. The outer portion of the bone is bent or broken by the exertion of slight force, antiseptic dressings are applied, and the limb placed in a straight fracture-trough, to be left undisturbed, if all goes well, for a fortnight.²

The chisel or 'osteotome' used by Dr. MacEwen is a narrow wedge of steel, properly tempered for the purpose, and ground to a fine edge, with an octagonal handle in one piece with the blade. We have had the pleasure of seeing this surgeon perform two osteotomy operations on the thigh. The 'osteotome' used was about half an inch wide, and the cutaneous incision about the same in length, and the operation was performed with the celerity and dexterity of almost the simplest operation of surgery. They were perfectly bloodless. Dr.

¹ See also vol. ii. p. 265.

² MacEwen, *Nature and Treatment of Genu Valgum*, 1880.

MacEwen favoured us by having in attendance several cases which had been operated upon from several months to two years previously. It required a practised eye to find a trace of the former deformity.

After MacEwen's operation nature fills up the triangular gap in the femur, just as she, by a return to natural growth where wanted at the ends of the femur and tibia, fills up the gap between the external condyle and the opposing articular surface, when the surgeon with the aid of mechanical apparatus, without osteotomy, has succeeded in holding these structures asunder, so as to enable her to act.

Apart from the greater simplicity and freedom from danger to the joint of MacEwen's operation compared with those which directly attack the maligned internal condyle, MacEwen's operation lengthens the outer side of the limb, attacks the defective external condyle by lowering it to its proper place and the articular surfaces of both condyles to their proper plane, and by supplying the bone in the femur necessary to keep it there. This version of the *modus operandi* of his treatment is ours, and differs from that offered by himself. He considers that he shortens the femur by compression with the osteotome along its inner side. We believe that relatively the same end and a better one is obtained in his operation by lengthening, as we have said, the outer side by forcible fracture and separation of the uncut part, or by such tearing and stretching asunder as occurs when a green-stick fracture is made.

Mechanical and adjuvant constitutional treatment, which can be carried out by the rubber, mother, or nurse when properly instructed and watched by the surgeon, is the proper remedy for all cures in early childhood, whether or not they be rachitic, nervo-muscular, synovitic, rheumatic, or purely atonic.

When, however, cases have been long neglected, when they have lost all elasticity of structures, and the bones are consolidated and the impairment of size of the external condyle and the opposite articulating surface of tibia is considerable, when the patella has abandoned its natural groove and lies outside of the external condyle, and adult age is near at hand, supra-condylar osteotomy is indispensable.

Having regard to the value of time, it may be said of adult severe inveterate knock-knee as of inveterate adult congenital club-foot, that it is practically incurable, and needs a readier method than instrumental treatment.

In rachitic curvatures termed *genu valgum*, but in which considerable curvature of the thigh and leg-bones has more to do with the distortion than any changes in the knee-joint, after the age of ten or twelve years, when the bones do not give to the hand of the surgeon the feeling of remaining elasticity, and when instrumental treatment may effect little improvement in the *curvatures*, multiple osteotomy can alone be relied on. Just as MacEwen has remarked that 'a hard and fast line' as to age for osteotomy cannot be laid down, so we may remark that so long as bones retain any rachitic softness, indicated by their capacity to yield on the application of force in a green-stick way when partially divided by the surgeon, they can be straightened without osteotomy.

Osteotomy may be required because of bone curvature and not for the *genu valgum*. It should be remembered that a moderate amount of permanent curvature of thigh and leg-bones is not incompatible with effective use in after life, even if they do not gradually become improved by muscular action, or become concealed in the female sex by the greater amount of adipose tissue which tends to cover asperities and projections, and favours symmetrical contour.

In estimating the value of osteotomy compared with instrumental treatment of cases of *genu valgum* and bone curvature in regard to the saving of time to the patient, it should not be forgotten that we have yet to learn from a large number of cases operated upon by different surgeons the average number of weeks which elapsed after osteotomy before the reunion of bone was perfect and the limb strong enough for active exercise, especially as under mechanical treatment the patient may take average exercise during the whole duration of it.

OSTEOTOMY FOR CURVATURE OF THE TIBIA.—Curvatures of the tibia both in the antero-posterior and lateral directions have been treated by two different methods, by the removal of a wedge of bone or by simple division in one or more situations. We consider that in almost every case as good a result can be obtained from one or more simple divisions of the bone as from the removal of a wedge, while the operation is shorter and the injury inflicted on the soft parts far less than in the latter case. Experience shows that it is not necessary for good union to have the surfaces of the ends of the divided bone parallel, or in apposition in their whole extent. The rapid and complete filling up of the gaps which must be formed in many and various osteotomies shows this. The gain in length also in a limb on which a simple osteotomy has been performed, as compared with one in which a wedge has been removed, is an important consideration. Section of the Achilles tendon has sometimes been required to favour entire repose of the limb during reunion of the bone.

OSTEOTOMY OF THE FIBULA.—The fibula plays apparently a less prominent part in knee and leg curvatures than the tibia. It can easily be severed by chisel-osteotome where most

prominent a few fingers' breadth below its upper end. It may snap asunder after the tibia has been severed. In one instance where Mr. L. S. Little had divided the tibia, the fibula unexpectedly gave way during examination of what had been the effect of severing the tibia. We took note of the fact that not only could the leg be entirely straightened, but that a certain amount of genu valgum which previously existed had suddenly disappeared. The mode in which this beneficial effect of loosening the fibula was effected was not at first very clear. We presume the explanation to be that in genu valgum, as the biceps muscle and its fibrous expansion along the outer side of the limb are tense, and that division of the fibula effectually relaxes this tension, it is probable that the tensor vaginæ femoris and the fascia lata are in a similar way relaxed.

OSTEOTOMY FOR THE RELIEF OF KNEE-ANCHYLOSIS.—Combined supra-condylar division of the femur, and section of the tibia below the knee, have been successfully resorted to for this ankylosis. It is preferable to resection and to amputation, but inferior to osteotomy at the part where the joint formerly existed.

It may be well here to mention that when a fractured sound leg or thigh in the young adult has been united at a considerable and mischievous angle, we have found the uniting 'callus' six months afterwards yield to well-directed gentle, gradual pressure.

We published in 'Deformities of the Human Frame,' 1853, p. 40, the particulars of a case of extreme distortion of this nature in a youth of 16. We have since treated two cases in young adults who presented a considerable curve forwards of tibia in the middle of its course about seven months after the accident, and five months after resumption of exercise. Both complained of pain at the most prominent part, sufficiently severe to cause lameness when walking and interruption of sleep. They were both relieved of pain, and the distortion rendered almost inappreciable by the same means.

In another case in which the man, aged 26, after compound fracture of the leg-bones, was, after three months' confinement, dismissed from treatment and permitted to use the limb. Six months after the accident he complained, when walking, of straining pain in the front of the leg, which he considered to be more prominent than when he first resumed exercise, and at the knee. The latter showed evidence of incipient inward inclination (genu valg.) when compared with the sound limb. Six months' use of a straight iron on the outside of the whole limb, including the pelvic portion, with straps, as in treatment of genu valg., to draw the knee outwards, moderate exercise with stiff-knee being permitted, sufficed to straighten the knee and somewhat reduce the tibial bulge. He was ordered to wear the apparatus with free motion at knee for six months longer, after which he was reported quite well.

Such facts suggest that it is not safe, in the case of a limb recently subjected to osteotomy, to expose it to active exercise and the carrying of heavy weights. If previously healthy, accidentally fractured limbs become after apparently firm reunion deformed, any neglect of due precaution after osteotomy will favour relapse of the operated limbs, though they remain capable of being again straightened by mechanical means. Such cases resemble the 'relapsed or incompletely cured' cases of club-foot after tenotomy, which have been due to premature use without the protection afforded by a support.

The following case also should warn us against performing osteotomy in a patient the subject of fracture which has united imperfectly.

A sensitive boy of 6, of precocious intelligence, who had had the bones of the leg fractured, and whose limb after apparent perfect recovery became much bent, was ordered a suitable instrument, in which he was allowed to walk during two years, until the leg was almost straight. The friends, unfortunately, became impatient, and were advised by the family surgeon to have osteotomy performed. The limb was straightened, but after some months the union was found to be defective, and after being again laid up for some time he was pronounced cured; but shortly afterwards (ten months from the operation) he died of pernicious anæmia. We are of opinion that the imperfect union, both after the accident and after the operation, and the pernicious anæmia, were parts of the same constitutional disorder; and further, we consider that the prolonged confinement after the osteotomy probably hastened the fatal event. Over-sensitive, precocious children are not good subjects for any surgical operation.

One of another class of osteotomy, an arm case, was treated by Sir J. Paget, Dr. Burchell, and myself, in 1876. It was that of a young lady, aged 15 years, whose left humerus had been fractured during the act of parturition and subsequently neglected by the friends. It would appear that the limb had been allowed to remain by the child's side, so that during growth the shoulder, elbow, and wrist-joints, and the bones and muscles in general, had undergone accommodation—changes of form and relation. Such changes had probably been favoured by a rickety condition which we suspect had existed in early infancy, for much difficulty was experienced in sawing the bone at the operation to be related. The humerus had united in a fairly straight line, but was somewhat rotated inwards. Owing, apparently, to this circumstance the child had grown up with an almost useless limb, undue pronation of the radius existing with no movement whatever in the direction of supination. The olecranon presented forwards and outwards, and the palm of the hand backwards. When she bent the elbow a singularly deformed movement took place. She had power of flexion and extension of wrist and fingers, which enabled her to grasp an object behind her, or when stooping to lift an article from the ground behind, the back of the metacarpus presenting in front. She had never seen the palm of her hand, or been able to feed herself with it or raise it to the head. The limb was somewhat smaller in all its parts and directions, to the extent that it was two inches shorter than its fellow. Section of radius was effected with the saw below the middle, the wound was sponged with solution of chloride of zinc, and was put up in cotton-wool and splint. Little febrile disturbance followed; at the end of five days healing was well advanced, and it was deemed advisable to apply a special apparatus for supination, which had been tested before the operation. After a few days some tension by the apparatus was commenced. In six weeks' time supination was complete, the palm for the first time presented forwards. The wound at this time was not quite healed. There had been no considerable suppuration or health disturbance, or interference with sleep or appetite, though she was of delicate aspect. She had latterly taken daily drives, and was sent to the sea-side for three weeks. She returned with the wound cicatrised. She was directed to continue the apparatus at night, and was immediately placed upon a

course of gentle passive exercises, manipulations, and finally of gymnastics. At the expiration of four months she had acquired the power of placing the hand behind her head, could employ it in dressing the hair and person, and in the use of the fork at table, and at six months support herself with both hands on the trapeze, the result being eminently satisfactory. The only visible trace of deformity which remained was that of a partial sinking of the reunited ends of the radius towards the ulna, affecting the normal straight outline of the external aspect of the forearm. Though the arm was short and small, it was daily becoming more useful, and the movements becoming more symmetrically performed.

Before operating in this case, it was a question whether the humerus should be divided and union be sought after giving the lower part of the limb a rotation outwards of a quarter circle and not the radius. It appeared to us all, however, that this bone would also require division, therefore the single and the smaller operation was preferred. No doubt the action of the apparatus had beneficially told upon the elbow and shoulder-joints.

W. J. LITTLE.

APNŒA; USUALLY CALLED ASPHYXIA.

DEATH FROM SUFFOCATION, HANGING, DROWNING, ANÆSTHETICS, POISONOUS GASES, &c.

THE chief characteristic of the mode of dying about to be considered being the continuance of the heart's action after the cessation of the respiratory process, in order to be logical we have abandoned the old and familiar word ASPHYXIA, signifying an absence of pulse (*ἀ, not; σφύζω, I beat*), and employed in its stead the term APNŒA (*ἀ, not; πνέω, I breathe*), though even the word apnœa fails clearly to explain the proximate cause of death, which is merely an absence of oxygen. For in certain cases of suffocation life is extinguished, although there be no impediment to the physical part of the respiratory process, and in these circumstances it is the absence of oxygen alone which determines the death of the individual. As the word apnœa is, however, applicable to the majority of cases, we employ it; for it clearly defines the great truth that without respiration there is no life. Man's earliest declaration of independent existence being his first inspiratory act; his seal to the abdication of life, his last expiratory effort.

At first many might imagine that as respiration is, to some extent, a semi-voluntary process, they can temporarily arrest it at pleasure. If, however, the time men are able to cease respiring be exactly calculated, no one can fail to be astonished at its extreme brevity. Not one in a hundred can cease breathing for a single minute without suffering great discomfort; and very few can hold their breath for two entire minutes without yielding to an involuntary and irresistible respiratory effort. The numerous stories heard and read of persons voluntarily holding their breath for five or more minutes are simply fables. For no human being can live after oxygen has been excluded from his lungs for three minutes. And the numerous reports of successful cases of resuscitation after prolonged complete submersion—such as half an hour, for example—are pure impossibilities, originating in imperfectly-observed data.

The reason why some persons are a long time in drowning, and even ultimately recover, is that they are never, or at least only for a very short part of the time, totally deprived of air. Every now and then their heads come to the surface of the water, and they obtain an inspiration. Even if they can but gasp in a small quantity of air, and that too accompanied with water, they may be able to survive for a long time. For it is only the total deprivation of air that kills quickly. A person can exist for an hour on a very small quantity of air, if it be but frequently enough changed. This fact we see illustrated every day in the persons of patients suffering from pneumonia supervening on phthisis, who struggle on for hours with only a small portion of their lungs capable of performing the functions of respiration. This leads to the question, *How long may a human being be under water, and yet recover?* If a person be completely submerged, and the entrance of water to, and exit of air from, the lungs not prevented, we believe recovery would be utterly impossible even after three minutes. For when a dog is completely submerged for two minutes and thirty seconds, it dies. This is invariably the case, even when the animal, after its removal from the water, is not only able to make spontaneous efforts at respiration, but actually capable of giving a cry.

Exactly the same thing occurs when an animal is confined in a jar of pure nitrogen gas. From the air in the lungs being rapidly replaced by a gas incapable of supporting life, the animal speedily perishes—much sooner than if the trachea was plugged and the lungs remained filled with air. These facts are of the utmost value in connection with the subject of treatment; for, paradoxical as it may appear, the best way to preserve life from apnœa, under certain circumstances, is to stop breathing. This is proved by the fact that if the trachea of a dog be ligatured, so that no water can enter and drive out the air from its lungs, it will perfectly recover, even after five minutes' complete submersion, and there is no reason to suppose that a human being would not do the same under similar circumstances.

SYMPTOMS OF APNŒA.—The first symptoms that manifest themselves when a healthy person is deprived of oxygen are feelings of thoracic fulness and discomfort, which gradually, but rapidly, assume the form of an intense oppression, immediately followed by violent respiratory efforts. The respiratory efforts are at first short and recur in rapid succession. They soon become deep, forcible, and prolonged, with a gradually-widening interval between them, until just before they entirely cease, when they again diminish in force and duration. During this period, which for the sake of convenience may be termed that of respiratory

effort, certain cerebral symptoms present themselves in somewhat of the following order:—In the earlier part, the patient feels a sensation of fulness in the head and giddiness; experiences singing in the ears, and has flashes of light dancing before his eyes. To these, it is said by persons who have been rescued from impending suffocation, succeed pleasing dreams, which, however, soon fade away, and give place to insensibility, which, in its turn, is speedily followed by convulsions and coma.

The appearance of the patient during the time just described undergoes a marked change. There is an extremely anxious expression of countenance, blueness of the lips, projection of the eyeballs, distension of the vessels of the face, head, and neck, frothy mucus (occasionally sanguineous) about the mouth, an involuntary passage of urine and feces, sometimes even an emission of semen, with or without erection. All of these symptoms are modified, and supervene with more or less rapidity, according to the mode in which the apnœa has been produced. Although apnœa may be induced in a great variety of different ways, each of which presents its own peculiarity, it is unnecessary at present to dwell upon them, from the diagnosis of the case being in general attended with no difficulty, from the fact that its history clearly explains the symptoms. It has, however, happened that the medical attendant has been purposely misled into an error in diagnosis by the relatives of the patient, who, in their desire to protect the honour of the family, have occasionally not hesitated to trifle with the life of one of its members. It is therefore of importance to call attention to the danger which a practitioner occasionally runs in such cases, of mistaking the cause of the symptoms and thereby falling into an error in treatment. This can scarcely be more forcibly done than by briefly relating a case recorded by Mr. Thomas Stainthorpe.

On one occasion, Mr. Stainthorpe was suddenly called after midnight to see a clergyman. On arrival he found the gentleman in bed, unable to speak, insensible, and presenting the symptoms of apoplexy. The relations heard the remarks of the medical attendant, listened to the line of treatment suggested, and assisted in its performance, without giving the slightest hint as to the true cause of the symptoms, or making any allusion to the fact that the patient had a few minutes before been found suspended by the neck to the top of his bed. Mr. Stainthorpe, in the belief that the case was one of apoplexy, opened the veins of both arms and extracted three pints of blood. This was followed by other treatment considered applicable to the case; but it was not until ten hours had elapsed that the gentleman was able to answer questions; whereas, if the medical attendant had been honestly informed of the cause of his patient's symptoms, he might probably, with a little artificial assistance to respiration, have restored him in as many minutes. The gentleman recovered.¹

Apnœa arising from disease may give origin to precisely the same train of symptoms as that supervening upon an accidental mechanical obstruction to the respiratory process; the only difference being that the symptoms in the former case usually progress more slowly, as, for example, in cases of death from apnœa caused by œdema of the glottis; from the trachea becoming blocked up with a false membrane, as in diphtheria and croup; from the accumulations of mucus, as in bronchitis; from insufficient healthy pulmonary tissues remaining to admit of the blood becoming arterialised, as in pneumonia; and from compression of the lungs from effusion, as in double pleurisy.

In all these cases there is one remarkable circumstance observable—namely, that the lividity and congestion of the face are almost, if not quite, as apparent as in cases arising from a ligature round the neck, by which the descent of the blood through the jugular veins is interrupted. The same remark is equally applicable to cases in which the disease is external to the trachea; as, for example, in cervical tumours, aneurism, hypertrophied thymus, &c., which produce apnœa by their pressure on the trachea.

The explanation of the lividity is simple enough. The face and lips are livid from the arteries conveying venous instead of arterial blood. Secondly, they are congested on account of the arrested circulation in the lungs, causing the right side of the heart and the large veins opening into it to be engorged.

SECONDARY APNŒA.—We have now to call attention to the fact (which has been frequently observed, more particularly in cases of drowning) that an individual may apparently recover from the primary effects of apnœa, and after the lapse of some minutes, hours, or days, suddenly expire without any apparent cause. This secondary death occurs not only after drowning, but after each and all of the causes of apnœa. Indeed, it is not much less common after hanging than after drowning; and it has been equally observed after the administration of amesthetics.

Lest some may imagine that the secondary form of death now under consideration is nothing more than death following upon imperfect resuscitation, we may at once inform them that it is entirely different. Take, for example, a case of drowning; and we may quote the following, which we heard of in consequence of the gentleman in whose practice it unfortunately occurred being unjustly accused of having treated the case improperly. The patient, a healthy young man, while bathing accidentally got out of his depth, and before being rescued became much exhausted. On his removal from the water, he was quite unconscious, although the respiratory process still continued. The usual restoratives were applied, and the patient

¹ *Lancet*, Oct. 1, 1859.

was soon able to speak. He was taken home, and, at the suggestion of the medical attendant, who considered him out of all danger, had some opening medicine given to him and was put to bed. In the middle of the night (about ten hours after his immersion) he was suddenly heard by a person who occupied the same apartment to make a noise, as if in a convulsion. When a light was obtained, it was found that he had become quite livid in the face; and before medical aid could be procured, he expired. At the post-mortem examination nothing was detected to account for the sudden death.

This we regard as a case of death from secondary apnœa.

Sir B. Brodie relates the case of a lad who was found hanging by the neck insensible, who, after apparent recovery, died twenty-four hours after he was cut down; and at the post-mortem examination nothing abnormal was detected in the body except congestion of the cerebral vessels.

Linhart, again, relates a most interesting case of a perfectly healthy peasant who died eighteen and a half hours after having been rendered only partially insensible by an ounce and a half of chloroform inhaled in the usual way—over a period of thirty minutes. The patient continued perfectly well until the next morning at six o'clock, when he suddenly died. On examining the body, twenty-four hours after death, all the organs were found healthy.

These cases, which have generally been classed under the head of death arising either from collapse or of spasm of the glottis, are certainly peculiar; but nevertheless we consider them as merely the secondary results of the arrested interstitial nutrition that took place during the period that respiration had been partially arrested.

The peculiar condition of the red blood-corpuscles, which is presently to be mentioned as occurring in cases of drowning, may in some degree aid in the understanding of what is here termed secondary apnœa. For while abundance of serrated blood-corpuscles are found in the blood of the right side of the heart, there is not only a total absence of them in the watery blood of the left, but a great number of the normal blood-cells have disappeared; the field being occupied by small granular bodies, looking something like nuclei, that might have escaped from the swollen and burst corpuscles. This description of the blood refers to a fatal, and consequently exaggerated, case; but it is very easy to imagine a less formidable one. Although we here only speak of the visible effects of drowning upon the circulation, yet how many and intricate may be the changes that take place in the blood during the period of apnœa that are entirely beyond the cognisance of our senses! Indeed, in order properly to comprehend the meaning and pathology of secondary apnœa, it is necessary for us to take a glance for a moment at the whole process of nutrition.

It is a common belief that, as we eat and sleep at stated periods, nutrition is not a constant but an intermittent function; an opinion we entirely dissent from, as it is not in conformity with the present state of physiological science. To our mind nutrition appears to be a constant process—fluctuating, it may be, but nevertheless continual. The secretion of milk, urine, bile, and semen goes on during every hour of the day and every minute of the night. It is only the expulsion of the accumulated products that is periodic. So again with food. Just as the camel can pass several days without drinking, if he has previously filled his reservoir with water, so can a man go several hours without eating, if he has previously laid into his stomach a stock of food. The animal, like every other machine, to do constant work must have a constant supply of material. Life, indeed, might not inappropriately be compared to a web of cloth made of the purest American cotton, and each stoppage in nutrition to a flaw. Thus each disease, each temporary illness, although not producing an actual gap, would weaken the web by introducing into it an inferior quality of cotton. It might only be a single thread, or it might be many threads; but still the web would be weakened by their presence. Do we not every day see around us evidence of the flaws in the human webs? Look, for example, at the teeth. Are the furrows we occasionally see across them not the tell-tales of the severe illnesses of youth? Are they other than the marks of arrested nutrition? So again with the nails: do they not, after a smart attack of scarlet fever, indicate by their grooves the severity of the illness? Can the falling out of the hair after typhus be said to be due to anything else than temporarily arrested nutrition? Even the mind itself does not escape the general ill. Bad tissue deposited produces bad memory. Old people remember distinctly all that occurred to them in their youth, when good tissue was being laid down; but forget the occurrences of the previous day, when in old age the material is of an impaired quality. So also it is found, and for a similar reason probably, that it occasionally happens that, after a severe illness, little is remembered of what occurred during it. Interstitial nutrition is constantly going on, and it cannot be for an instant interrupted without threatening to bring the machine to a stand-still. Moreover, we might go a step farther, and say that the more quickly the machine does its work the sooner will its labour cease. Waste and repair cannot go on indefinitely in the animal body any more than in the locomotive. Supply the engine with coals and water as carefully as you will, still it will wear out. That is, however, not the point with which we have at present to deal. It is only the temporary arrest of the supply of material we are now considering; and, as we have already said, during the period of apnœa it is that supply that is interfered with, and makes the flaw which, although not sufficiently great to produce at once a rent in the web (immediate death), sooner or later causes it to give way (secondary apnœa).

This theory will be still better understood if we illustrate it by what is observed to occur to horses after temporary starvation.

Many years ago the French Government appointed a Commission to inquire into the effects of starvation on cavalry horses; and the results obtained are not only interesting, but most important. Among others, for example, it was found—

1st. That after ten days' total deprivation of food, a horse is still able to gallop, although not very long; and after being again well fed, makes a tolerably rapid recovery.

2nd. That a horse may live for twenty days without nourishment of any kind, and still make a temporary recovery.

3rd. That an animal starved for over ten days, although he makes a temporary recovery, never regains his pristine strength, no matter how well fed he may subsequently be.

Thus it was found, that though the horses that had been kept fasting during a period of ten days, and then well fed, apparently recovered rapidly from the effects of the starvation, yet they never became as strong as other horses, and that they succumbed to disease much more readily than others. This failure in the vital stamina, if it may be so termed, we believe was owing to the mal-nutrition that occurred during the previous term of starvation. The subsequent death of the horse might therefore be said to be the secondary result of starvation.

This, then, gives the key to our theory of secondary apnœa.

POST-MORTEM APPEARANCES.—The external appearances presented by individuals in cases of death by apnœa vary according to the manner in which it has been induced, as well as with the period that has elapsed between the extinction of life and the examination. If, for example, the examination be delayed for twelve hours, the signs presented by the body differ but very slightly, if at all, from those frequently found in persons that have died from other causes. Positive evidence, indeed, can only be obtained in such cases by an internal inspection, and even that must be carefully made, otherwise the cause of the apnœa may escape detection. This remark is specially applicable to cases of accidental and suicidal apnœa.

If the body is seen within three or four hours after death, its external surface will be found to present numerous discolorations. The lips are blue, and oftentimes covered with frothy mucus, which occasionally presents a slightly sanguineous appearance. It ought not to be forgotten that frothy, even sanguineous, mucus may be found about the mouth in other cases of sudden death besides those arising from apnœa. Such is the case in epilepsy; in heart-disease; and on the very day of writing these lines we saw it in a marked degree in a case of concussion of the brain. The driver of a pianoforte van was thrown violently from his seat against a lamp-post; and on being brought to University College Hospital, a slightly bloody tinged froth around the mouth and about his nostrils was specially observed. He had been dead about fifteen or twenty minutes. The tongue is often swollen and livid, and not unfrequently shows marks of the teeth upon it. This is particularly noticeable in those cases in which a convulsion has preceded death. The eyelids are half open and the pupils dilated. The countenance is generally placid, the skin of the face usually pallid, or if discoloured at all, possessing a faintly livid transparency.

In apnœa from the external application of mechanical means, evidences of the mode by which death has been induced generally remain visible for some hours. There may be abrasion, ecchymosis, or laceration at the seat of injury. There may be the mark of a cord or of fingers upon the neck. The hyoid bone may be fractured, the cartilages of the larynx dislocated; and various other evidences of mechanical injuries, according to the manner in which the apnœa has been induced.

On the other hand, it must not be forgotten that death may arise from mechanical means, and not a trace of its nature be visible to the eye. This has frequently happened in cases of smothering and plugging of the fauces and windpipe. In such cases, therefore, the existence of the apnœa can only be detected by an internal inspection.

Even in cases of death by hanging, if the body be cut down immediately after the extinction of life, the mark of the cord or rope entirely disappears within a very few minutes, so that a person not examining the body until half an hour or more after death, would fail to discover any traces on the neck indicative of the manner by which life was extinguished. This arises from the fact that where there has been no excessive application of violence the mark of the cord is due (contrary to the common idea) to post-mortem constriction. So true, indeed, is this, that if a human body be suspended by a cord immediately after death from ordinary disease, and allowed to hang for more than half an hour, the mark of the cord becomes permanently visible. These facts ought never to be forgotten in post-mortem examinations of medico-legal import.

Moreover, the post-mortem appearances in cases of poisoning by the substances included under the head of toxic vapours vary as much as the symptoms themselves. In some they are even totally opposed. Thus, for example, while the muscular tissues and organs of an animal poisoned with sulphuretted hydrogen are of an intensely dirty-black colour, those of an animal that has succumbed to the effects of pure carbonic oxide are of the most beautiful vermilion hue. So it can be readily imagined that, even if we felt inclined, it would be impossible for us, in the short space at our disposal, to give an outline of the symptoms and post-mortem appearances produced by all the substances that might be included under this heading.

Rigor mortis.—As regards *rigor mortis*, it may be said that it usually sets in early; and

this is particularly the case after drowning in cold water, when a state of semi-freezing has been frequently observed instantly to succeed, if not actually to usher in, death. So firmly are substances occasionally grasped in the clenched hand of the drowned in cold water that they are only to be extracted from it by the application of great force.

Condition of the brain.—The state of the cerebral vessels in cases of apnœa depends entirely upon its form. Thus in strangulation they are engorged with dark venous-coloured blood; while death by poisonous gases is always connected with an exsanguine state of the cerebral vessels. The appearances of hyperæmia, occasionally observed, being merely the result of the post-mortem mechanical distribution of the blood. Even where the animal has been strangled with a cord round its neck, if the head be kept somewhat higher than its body an anæmic condition of the brain is gradually assumed after death. If these assertions be correct, they clearly point to the necessity in medico-legal cases of carefully taking into consideration the position occupied by the body after death, before drawing any conclusions from the state of the cerebral vessels.

Condition of the heart and vessels.—Particular attention has been paid to the condition of the heart and great vessels in cases of death by apnœa. It is usual to find the right side of the organ, both auricle and ventricle, as well as the large vessels attached thereto, highly engorged with dark-coloured blood. The left side of the heart, on the other hand, is in the majority of cases found empty; and if it contains blood, the blood is of the same venous hue as that found occupying the right side of the organ. The blood throughout the whole body, indeed, is of a similar dark tint, except in cases of carbonic oxide poisoning, when it is of a scarlet hue. Some state that it presents the additional peculiarity of being fluid; but this is far from being always the case.

In cases of drowning the blood in the left side of the heart contains much more water than that on the right; and when examined microscopically, the blood-corpuscles from the two sides of the heart present entirely different appearances. Thus, for example, we ascertained that while in the blood of the right auricle or ventricle the corpuscles may be nearly all serrated, in the watery blood from the left side of the organ it is not only frequently utterly impossible to detect a single serrated corpuscle, but in the latter blood, many of the cells have swollen up, burst, and allowed their colouring matter to escape, and stain the serum of a deep red colour. In some cases we have also noticed that occasionally, when there was scarcely a whole blood-corpuscle to be seen, the field of the microscope was occupied by an immense number of small bodies like escaped nuclei, and we are not yet quite certain that they were not nuclei, notwithstanding it was dog's blood (which is supposed to possess only non-nucleated blood-corpuscles) we were examining. The portal system is greatly engorged. The liver, kidneys, and spleen specially partake of the venous congestion. It may indeed be asserted, in general terms, that in death by apnœa all the internal organs are more or less engorged. Most authors have stated that the lungs are particularly so; but although we have had our attention specially directed to this point for many years past, and enjoyed several opportunities of being present at the autopsy of persons who have perished by apnœa, we are forced to admit that it is not invariably the case.

There being no more blood in a person killed by apnœa than in one who has died from any other cause, it is easy to see how there cannot possibly be a general engorgement of the whole vascular system. If one part of the body is particularly congested, another must be proportionally anæmic. If the congestion of the internal organs be very marked, there is a corresponding pallor of the external surface. The venous system is full of blood because the arterial is empty; and the simple reasons are—1st, that the pulsations of the heart and vessels continue after the respiration and consequent circulation in the lungs is stopped; and 2ndly, the resilience of the arterial coats prevents the return of the blood into them from the capillaries.

Condition of the respiratory system.—In cases of death by hanging, strangulation, and suffocation, the lungs present no characteristic appearances; unless it be that, on opening the chest, their tissue does not collapse in the usual manner in cases where the exit of the air by the trachea is prevented by constriction or plugging of the windpipe. In cases of death from the inhalation of sulphuretted hydrogen gas, the pulmonary tissue is blackened, and in those from carbonic oxide gas, it is of a fine vermilion hue.

It sometimes happens when the apnœa is due to the inhalation of anæsthetics, such as chloroform, there are one or more small extravasations of blood found in different parts of the pulmonary tissue. Sometimes these hæmorrhagic effusions are quite superficial, at others deep seated.

As in cases of apnœa by drowning the lungs present characteristic appearances, we must make special allusion to them.

Some say that water never penetrates the lungs, in consequence of a spasm of the glottis being induced as soon as water comes in contact with the opening to the air-passages. Others again, with equal confidence, assert that not only water, but any foreign substance, such as mud, duck-weed, and chaff, which may accidentally chance to be floating in it, are carried into the lungs. Our personal experience entirely negatives the former, and supports the latter statement. For into the lungs of every animal, without a single exception, we experimented upon, the fluid in which the animal was immersed freely entered. The extraordinary force by which substances are drawn into the lungs in cases of drowning was estimated by the Committee of the Medico-Chirurgical Society, and found to be equal to the

raising of a column of mercury four inches.¹ When dogs were drowned in plaster of Paris, on examining the lungs after death the white plaster could easily be detected in the minute bronchial tubes. While the lungs of animals rapidly drowned in water, when examined immediately after death, are found to be saturated and sodden with water to such an extent that they pit on pressure, feel doughy to the touch, are exceedingly heavy, and incapable of collapsing. On section of the pulmonary tissue, frothy water stained with blood pours out at every point.

How can this fact be reconciled with the statement so often made that no water is to be found in the human lungs after death by drowning? We ourselves failed to detect water in the respiratory organs of a young woman, aged 23, who committed suicide by drowning. The lungs, when examined twenty-four hours after death, crepitated readily on pressure, except in the most depending portions, to which the blood and water, if there was any, had gravitated. Our failure in detecting water in this case, however, did not excite the least surprise, notwithstanding our being in possession of the above-mentioned data; from our being at the same time acquainted with the important fact of the powerful absorbing power of the pulmonary tissue. It is almost impossible to say how much water may be taken into, and disappear by absorption from, the lungs during slow drowning. It must be remembered that the extinction of life in cases of submersion is not due to water entering the lungs, but solely to the absence of oxygen. If air be allowed to enter the lungs at the same time as the water, the animal suffers little or no inconvenience from the presence of the latter in the pulmonary tissue. One can pour into the lungs of a dog a continuous stream of water, and the animal yet live. It is only during the first few minutes that water induces much irritation, and causes the animal to struggle and cough. The irritation soon subsides; and if the water be allowed along with air steadily and slowly to flow into the lungs, no apparent inconvenience arises. Even half an ounce may be suddenly thrown into them, and, after the dog makes one or two deep inspirations, entirely disappear. This may be repeated at intervals of a few seconds for at least half an hour, without in the slightest degree endangering his life, until fifty ounces have been introduced into the lungs; and on killing the animal an hour or two afterwards, not a trace of the liquid may be found in the pulmonary tissue; the lungs at the same time appearing none the worse for the experiment.

In an animal that has long struggled, and frequently got its nose to the surface for a sufficient length of time to inhale a little air, there is far less water found in the lungs than in one that has been from the first wholly submerged. This is precisely what happens with human beings, who, even in cases of suicide, generally struggle for some time, and thus succeed in obtaining occasional gasps of air, at last succumbing to the combined effects of suffocation and exhaustion. Again, it must not be forgotten that it may happen that on removal from the water the body may have been so placed as to admit of the exit of any fluid that was present in the trachea and lungs at the moment of death.

CAUSE OF DEATH IN APNŒA.—In attempting to explain the cause of death by apnœa, it is necessary to go a step or two farther than has hitherto been done; and, instead of merely limiting the question to an explanation of the most prominent of the effects of this mode of death, to attempt to follow up the subject until we arrive at the præmial cause of the arrest of the vital functions. In order to do this, it is necessary to begin ab initio.

As is well known, a continual afflux of arterialised blood to the various animal tissues is a condition not only important but imperative to the continuance of life. All the molecular transformations of organised matter, of which 'life' is but the manifestation, are so entirely dependent on the continued supply of scarlet blood, that no sooner is it cut off than they instantly cease. Without oxygen there can be no life. Not a single new cell can be formed, not a single old one can be destroyed, without the influence of this all-important agent. From the first moment the animal germ springs into existence, during its development into tissues, and throughout its whole life as an organised body, up to the time of its death, arterialised blood is being uninterruptedly employed; and in exact proportion to its supply, *ceteris paribus*, are the many and intricate organic functions accelerated or retarded. Nervous action, muscular contraction, secretion, and excretion are all equally under its sway; so that it is impossible to feel in the least degree astonished that in apnœa, which essentially consists in the arrest of the oxygenisation of the blood, all the functions of life should be rapidly brought to a standstill.

It may be said, then, that the cause of death in apnœa, no matter in what manner it be induced, is an absence of oxygen. We may add that in our opinion this absence of oxygen acts indirectly, and that the extinction of animal life is in consequence of the constituents of the blood not having undergone the oxidation process, which is essential to the proper performance of their functions when brought in contact with the various tissues and organs of the frame. The confusion of ideas, the unconsciousness, the convulsions, the stupor, the paralysis of the muscles, the stoppage of respiration, the arrest of the heart's action, appear to us to be one and all due to the same cause, *arrested interstitial nutrition*. It is thus seen, then, that what others have hitherto regarded as the primary cause of death in apnœa—namely, the stoppage of the circulation in the lungs, the failure of the heart's action, &c.—we look upon as merely the secondary effects of the arrest of nutrition.

¹ *Med.-Chir. Soc. Trans.* vol. xlv., 1863.

Apnœa may, we believe, with perfect justice be defined as death from arrested interstitial nutrition.

Apnœa the result of an absence of oxygen in the respired medium.—The simplest form of death arising from apnœa, or the non-arterialisation of the blood, is when there is no obstruction to the entrance of air into the lungs, but merely an absence of oxygen in the inspired gas. This is well illustrated, for example, when an animal is placed in a jar of nitrogen. It dies, and that too in a very few minutes; not from the introduction of any poisonous material into the system, but solely on account of the absence of oxygen in the inspired medium.

Nitrogen is perfectly harmless to animal life. We are constantly breathing it, and suffer no disagreeable effects from it. On the contrary, it is a necessary diluent of the oxygen of the air. The atmosphere normally contains no less than 79 per cent. of it. Nitrogen itself is, however, neither a supporter of life nor of combustion; hence it is that animals cannot live in it. Moreover, dogs die quicker in perfectly pure nitrogen than when strangled, for the reason previously given—namely, that the inhaled nitrogen displaces a certain amount of the oxygen from the air-vesicles, and thereby reduces the animal to the condition of one whose air-vesicles have been emptied of oxygen by water. The influence of nitrogen extends even somewhat farther. For, according to Graham's law of the diffusion, and Henry and Dalton's law of the absorption of gases, the inspired nitrogen not only displaces the free oxygen present in the pulmonary air-vesicles, but withdraws the absorbed oxygen from the blood itself. This is probably the true explanation of the fact that animals die more rapidly when placed in perfectly pure nitrogen gas than when suffocated in any other way. Hydrogen acts in a nearly similar manner; but its effects on the animal body have not been sufficiently studied to admit of our drawing any general conclusions from them. Some have even hinted that hydrogen gas has special toxic properties; and if so, it ought, properly speaking, to come under the next head.

Apnœa from the inhalation of toxic gases and anæsthetics.—There are very few gases that cause death by pure apnœa. Most, indeed all, with the exception of nitrogen and hydrogen, and possibly even the latter, kill by means of their toxic properties.

In the case of the inhalation of carbonic acid, carbonic oxide, coal gas, hydrocyanic acid, sulphuretted hydrogen, arsenuretted hydrogen, chlorine, sulphuric ether, chloroform vapour, &c., there may, no doubt, be an absence of oxygen in the respired medium; but in no one of these cases can this be regarded as the sole cause of the fatal result. Quite the contrary; it appears rather that the destruction of animal life in the majority, if not in all, of these cases, depends much more upon the entrance of a poisonous agent into the circulation than upon the mere deprivation of oxygen. Consequently the symptoms manifested in cases of death from these gases differ according to their chemical nature and the intensity of their poisonous properties. Let us take arsenuretted hydrogen, for instance; if this gas be so given as to exclude the simultaneous introduction of oxygen, the animal dies not only much quicker than it does when its windpipe is tied, but also quicker than when it is suffocated in pure nitrogen gas. The cause of the difference in the rapidity of death being simply due to the toxic effects of the gas upon the nervous system. With hydrocyanic acid the fact is even better exemplified.

Even carbonic acid circulating in the capillaries acts as a direct poison on the tissues. This we have seen well illustrated while studying the duration of the cardiac pulsations after different modes of death. Thus the heart of a cat that has been suddenly deprived of life by section of the spinal cord at the vital point will continue to pulsate, under favourable circumstances, for forty minutes after the animal's death; whereas the heart of a cat allowed to die slowly by strangulation, generally stops, under the same circumstances, in less than twenty minutes after the death of the animal.

Death from a mechanical impediment to the entrance of air into the lungs.—Persons crushed in a crowd may die of pure apnœa, and even those accidentally buried beneath a fall of earth or stones, as well as such as are strangled with a cord, garrotted with the arm, or throttled with the hand; but in none of these cases is pure apnœa of necessity the only cause of death. In many of these forms of death by apnœa it is evident that it must occasionally happen that the death is accelerated by the direct action upon the body of the cause producing the apnœa. Thus, even in those due to mechanical obstruction to the entrance of air into the lungs, it can readily be imagined that the patient does not always succumb from pure apnœa. Fracture of the ribs, rupture of the liver, and many other injuries, may arise from pressure on the trunk, and thereby accelerate death. But there can be no doubt that in the majority of cases of suffocation arising from pressure on the thorax and abdomen preventing the expansion of the chest and consequent inhalation of air, the apnœa *per se* is the immediate cause of death.

In cases of accidental or intentional strangulation, if much force has been employed in constricting the neck there may be considerable injury done to the larynx. The os hyoides may be fractured; the laryngeal cartilages broken, especially in old persons, in whom they have become ossified; moreover, there may be contusion, and even laceration, of the soft parts of the neck. As an illustration to these remarks, the following case of impending apnœa arising from fracture and displacement of the hyoid bone may be cited:—

On March 28, 1856, a little girl, aged six years, while jumping, fell with her neck across the rail of an iron bedstead. She was instantly seized with a fit of coughing, great dyspnœa, an inclination to vomit, and a copious flow of saliva. The saliva was partly tinged with blood. When brought to us, which was almost immediately after the receipt of the injury, there was

distressing difficulty in breathing, the face was of a livid blackness, and there were all the other symptoms of impending death by apnœa. On examining the neck we found a sharp body projecting beneath the skin. It was very angular and quite movable. On close inspection it was found to be the displaced ends of the fractured hyoid bone. One end of the bone rode over the other. By a little manipulation the fracture was reduced, and all the symptoms of impending suffocation, together with the copious flow of saliva, &c. rapidly subsided.

Death from submersion, as has already been shown, presents conditions differing widely from those met with in any of the other forms of death from apnœa, whether arising from the mechanical obstruction to the entrance of air into the lungs, or from the inhalation of poisonous vapours or gases devoid of oxygen.

Moreover, all persons who die in the water are not necessarily drowned. A man labouring under heart disease may suddenly expire from the thoracic shock received in coming violently in contact with the surface of the water. Persons falling upon water from a height have died from concussion of the brain and extravasation of blood under the arachnoid.

Persons have died of apoplexy while bathing; and the brother of a medical man whom we knew intimately died from an epileptic seizure supposed to have come on during the act of diving. This occurred in one of our public baths; he was seen to dive, as he usually did on first entering the water, but as he never rose again, a search was made, and his lifeless body was found lying at the bottom of the bath. The reason why his body did not rise to the surface was that his lungs by involuntary inspiration had become filled with water. He had suffered from epileptic attacks for several years.

While guarding against an error in mistaking epilepsy for drowning, one must be equally cautious not to fall into the opposite error of mistaking the convulsions of apnœa for those of epilepsy; for they may occur in cases of plugging of the fauces as well as in any of the other forms of death from cessation of the respiratory process.

The temperature of the water influences to some extent the rapidity of the fatal result. The temperature of the human body being, in round numbers, 100° F., death is more rapid as we descend towards the freezing and ascend towards the boiling point. The explanation appears simple enough, when we remember that intense cold paralyses the muscular energies of an individual, and thereby prevents his continuing the efforts requisite to enable him to get occasional inspirations; consequently the person becomes totally submerged more quickly in very cold water than he would otherwise be.

Heated water, on the other hand, seems to favour death by hastening the action of the already weakened heart, as well as by accelerating tissue-metamorphosis, and thereby increasing the demand for oxygen.

TREATMENT IN CASES OF IMPENDING DEATH BY APNŒA.—The causes of apnœa are, as we have seen, so various that it need scarcely be remarked that different modes of treatment must be adopted in different cases; but there are several general rules which are more or less applicable to all cases. These are:—

1. Remove or stop the cause of the apnœa, whatever it may be.
2. Immediately remove from the mouth and nostrils all froth and mucus, of which there is usually a considerable quantity, and should the case be one of drowning, in addition to the removal of the mucus from the mouth and nose, hold the patient by the heels for a few seconds in order to allow of the exit from the trachea and lungs of any fluid that may be present in them.
3. All tight articles of clothing are to be at once removed from the neck and chest. For example, the cravat is to be taken off, the shirt unbuttoned, the corset unloosened, &c.
4. Place the patient in the most favourable position to receive a free supply of fresh air.
5. Should it happen that the patient is already so nearly dead that his tongue sinks back into the fauces, and is thereby likely to interrupt the entrance of air into the trachea, it is to be drawn forward, and, if necessary, held there.
6. If the respiratory movements have ceased, or become few and feeble, artificial respiration is to be performed by one of the three following plans:—
 - (a) Mouth-to-mouth insufflation, which is only applicable to new-born and young children.
 - (b) Intermittent manual pressure on chest and abdomen.
 - (c) Silvester's method of artificial respiration.
7. Before attempting the performance of either of these means of resuscitation, the patient must be laid flat on his back, with the shoulders raised by a pillow, a folded-up coat, or other contrivance, and the head allowed to fall well backwards, so as to allow the air to enter freely through the glottis. So prepared the—

Mouth-to-mouth insufflation is performed as follows:—The child being placed on a pillow on the table, with its head well back and to the operator's left hand, the operator, after wiping the mouth and nostrils clean, should seize the larynx between the thumb and forefinger of the right hand, and press it gently but firmly upwards and backwards. This is done with the object of facilitating the entrance of air into the lungs, and at the same time preventing any passing down the œsophagus into the stomach. The nostrils are then closed with the left hand, and the operator proceeds to distend the child's lungs with air by placing his lips over its mouth and blowing steadily into it. Having done so, he removes the hand from the larynx and gently aids in the re-expulsion of the air from the lungs by pressure on the lower

part of the sternum. This is to be repeated twenty-five or thirty times in the minute. As an example of this mode of procedure, the following case, which to us is one of more than usual interest, may be related :—

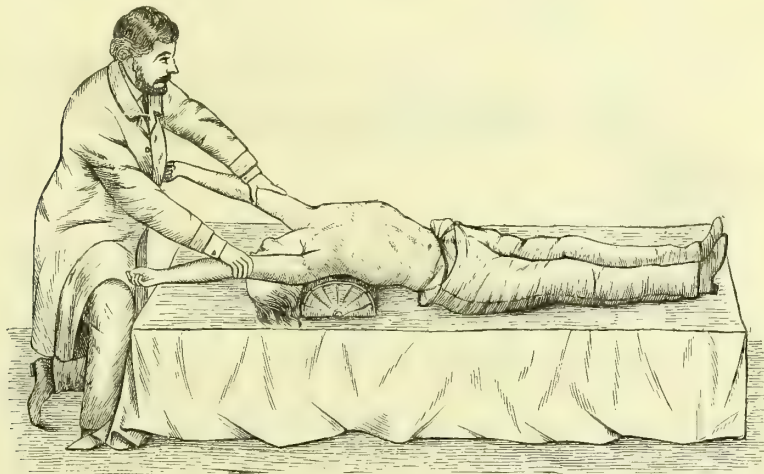
In 1850, while house surgeon to the Royal Maternity Hospital in Edinburgh, we extracted a child by the Cæsarean section after the death of the mother. It was only a seven-and-a-half months' child, and on extraction neither pulsation in the cord, nor the slightest movement of the heart, was perceptible. Mouth-to-mouth inflation was immediately had recourse to, in the manner above described ; and after at least ten minutes' labour we succeeded in restoring the heart's action, which was soon afterwards followed by respiratory movements, which, though feeble for a time, soon became sufficiently strong for the purposes of life. After the lapse of thirty-three years the individual is not only alive, but married, and the father of a family. Now living at Walworth.

Artificial respiration by intermittent pressure on the thorax and abdomen.—As is familiar to every one, a certain volume of air can be expelled from the thorax by forcible compression of its walls ; on the removal of the pressure, the walls of the chest return to their former position in consequence of their own elasticity, and air rushes into the lungs in order to fill the vacuum thereby produced. Consequently, by a regular repetition and relaxation of pressure, a species of artificial respiration may be induced. The volume of air inhaled and expelled varying with the amount of the pressure.

Manual pressure equal to about thirty pounds may be with perfect safety applied to a healthy adult human thorax.

In making the pressure, care is to be taken to observe if any food is forced out of the stomach, which may happen if that viscus is full ; and if so, it is necessary to prevent it

FIG. 209.



getting into the windpipe. This may be readily done by placing the patient for a few seconds on his face and forcibly expelling the food by pressure on the back.

The manual pressure ought to be made on the lower part of the sternum, for the resilience of the thoracic walls is there greatest ; and pressure on the abdomen at the same time is not to be omitted, or the diaphragm will descend, and counteract the benefits derived from the pressure made on the lower part of the chest.

The Silvester method of artificial respiration, which is by far the most effectual mode of obtaining an interchange of the pulmonary gases, is performed by alternately raising and depressing the arms, as exemplified in the figs. 209, 210, which themselves describe the mode of procedure more plainly than words can. As is observed in the figure, the patient's shoulders are not only well raised, but his head (as Dr. Howard suggested) thrown well back. On bringing down the patient's arms they should be gently and firmly pressed against the sides of the chest, so as still further to diminish the cavity of the thorax. This pressure can be exercised with greater facility and equal effect by pressing the arms on the lower third of the sternum. By alternating the movements of the arms and pressure of this kind, a regular exchange of air can be produced, varying in quantity from thirty to fifty cubic inches. An amount more than is requisite for the purposes of resuscitation.

8. If there be sufficient assistance at hand, the Silvester method ought to be employed in all cases in which artificial respiration is considered necessary ; but where the medical attendant is alone, simple manual pressure is the quickest and easiest that can be adopted. It only differs from the Silvester method in this respect, that in it the air is forcibly expelled from the lungs, and then allowed to enter, in consequence of the vacuum produced in the thorax by the re-expanding of the walls by their own elasticity ; while in Silvester's method the air is forcibly inhaled and expelled by raising and depressing the ribs. In both cases the

respirations should amount to at least thirty, or even forty per minute. The natural respirations are only eighteen per minute; but in cases of resuscitation, as our object is to arterialise the blood even more rapidly than in health; and as we cannot introduce by artificial means the same amount of air that is taken in by the normal efforts, we must proportionally increase the number of the respirations.

9. Should the apnoea be the result of mechanical constriction of the chest, as from a fall of earth or stones, by which one or more of the ribs may have been broken, the manual pressure and other ready methods are to be avoided, and artificial respiration by means of the Silvester method alone employed.

10. As soon as natural respiratory movements recommence, cease the employment of artificial means, unless the efforts are feeble and imperfect, when they may still be aided for a time with advantage.

11. As soon as the patient is capable of swallowing—and sooner, if a stomach-pump be at hand—administer a cupful of warm coffee or tea, with a couple of drachms of spiritus etheris nitrici in it; or if that is not at hand, a tablespoonful or two of brandy or other spirit.

12. Use warm frictions all over the body, more especially on the limbs, to aid the circula-

FIG. 210.



tion; and the more the skin is exposed to dry warm air the better, as even cutaneous respiration aids in the arterialisation of the blood.

13. When the temperature of the body is much reduced, as in cases of drowning during the cold winter months, aid in restoring it by means of a hot-water or air bath. If by the latter, place the head of the patient so as to keep the rarefied hot air from entering the lungs. Artificial respiration by pressure and frictions with the hand can both be readily applied while the body is in a warm bath. The bath should not be too hot (not above 110° F.), as it is not desirable, for the reasons formerly given, to raise the bodily temperature above its normal standard. Nor should the body be retained in the hot bath after the normal temperature has been restored.

TREATMENT AFTER THE BREATHING HAS BECOME NATURAL.—*a.* Give the patient some warm nutriment, to which a small quantity of stimulant is added; beef-tea, chicken-soup, coffee, or tea with one or two tablespoonfuls of brandy.

b. Put him into a well-aired bed with hot bottles to his feet, and encourage sleep.

c. Let him be carefully watched during sleep in case of secondary apnoea; at the slightest symptom of which let gentle frictions and, if necessary, artificial respiration be again had recourse to, and give volatile stimulants, such as the spiritus ammoniæ aromatici, or spiritus etheris nitrici.

GEORGE HARLEY.

ON PARASITES, AND THE DISEASES WHICH THEY PRODUCE.

UNDER the term 'parasites' might properly be included all the organised beings which exist during a part or the whole of their life at the expense of other living animals or plants. In this sense an innumerable host of creatures would be included under the term, belonging to both the animal and vegetable kingdoms. These have been divided into *true* and *false* parasites; and the former have even by some writers been erected into a distinct class, or rather into distinct classes, under the names of ento- and epi- zoa, or ento- and epi-phyta; but, in a scientific point of view, it is obviously improper to maintain any such classification.

Parasitism is to be regarded more as an accident than as an essential attribute; and the mere circumstance that an organism lives at the expense of another living being affords no valid ground of distinction between it and others whose nutriment is derived from dead organic matter. It is, moreover, now universally admitted that all the so-termed entozoa, &c., belong to some one or other of the larger groups of non-parasitic forms already constituted in either kingdom. In the case, for instance, of parasitic animals, we find not only that they nearly all belong to the sub-kingdom Annulosa, but that they also fall into existing classes in it. The most that can be said of any among them is that they appear to constitute groups of ordinal value.

In any general account of the subject, therefore, parasites would have to be regarded in their relations to numerous closely-allied forms; and the study, consequently, would be one of very great extent. It is also, from many circumstances connected with their life-history, one of extreme interest both to the naturalist and the physiologist. Here, however, we have to do almost exclusively with the surgeon; and the limits and objects of an article like the present preclude both the possibility and the necessity of considering the subject in any such extent. We propose, therefore, to give an account only of those parasites the consequences of whose invasion are likely to be brought under *surgical* treatment; and in doing this to enter only so far into their natural history as may be necessary for the suggestion of curative or prophylactic measures.

The principal parasitic organisms belonging to the animal kingdom, including both Ecto- and Entozoa, are found in the classes INFUSORIA, COLECIDA, ARACHNIDA, and INSECTA.

I. INFUSORIA.—Four or five minute organisms belonging to this heterogeneous class have been described as occurring in the human subject. They belong to the families Monadina and Holotricha. The former includes all infusory animalcules presenting a simple and apparently homogeneous body, furnished at one end with one or more elongated vibratile filaments. The family, however, is a very doubtful one in its relations to the animal kingdom, and it is pretty certain that the majority, if not the whole, of the Monadina merely represent the motile zoospores of various algæ or fungi. It is also extremely doubtful whether they should in any case be regarded as parasites, and not rather as merely the accidental concomitants of putrefaction.

The supposed parasitic Monadina belong to the genera *Cercomonas* and *Trichomonas*; the former characterised by the presence of a single vibratile filament, and the latter by that of two or more. The species of *Cercomonas* noted as parasitic are, *C. intestinalis*, *C. urinarius*, and *C. saltans*. The situations occupied by two of these forms are sufficiently indicated in their names, whilst the last is described as occurring in the discharge on the surface of foul sores; but its occurrence must be very rare, to judge from our own observations.

The only species (*T. vaginalis*) referred to the genus *Trichomonas* presents points of rather more interest. Originally noticed by M. Donne in the mucus of the vagina, he at first supposed it to be diagnostic of a gonorrhœal discharge, but subsequent observations by himself and others have shown that this is not the case. In fact, according to Kölliker and Scanzoni, it was found in the majority of the women examined by them, either pregnant or not. Its presence would appear, nevertheless, always to be accompanied by some morbid condition of the vaginal secretion, though that need not be exclusively of a specific nature. It is to be remarked, moreover, that its habitat is exclusively the vagina, as it is never found even in the cervix uteri. The animalcules vary in length from 0^m.008 to 0^m.018, and they are usually furnished, in addition to the whip-like appendages, with a few cilia at their base. In their natural nidus they exhibit active movements, which, however, soon cease on the addition of

water, in which they swell up into a spherical form, and assume very much the appearance of ciliated epithelium-cells, for which they have sometimes been mistaken.

In the family Holotricha, among the true ciliate infusoria, the only parasitic form observed, if it really deserve the name, is a species of *Paramœcium* described by Malmsten as occurring in the cæcum and colon.

II. SCOLECIDA.—Of the seven orders into which this class or subclass of Annulosa has been divided, five may be said to be composed almost entirely of parasitic organisms, amongst which are included all the more important forms likely to interest the medical practitioner. But of these all that it appears necessary here to notice are—

1. The Tæniada, or tape-worms.
2. The Trematoda, or fluke-worms.
3. The Nematoda, or thread-worms.
4. The Gordiacea, or hair-worms.

I. The *Tæniada*, or *tape-worms*—sometimes also termed *Cestoidæa* or *Cestoda*, and in which are also included the so-termed *Cystica*, or *cyst-worms*—constitute an order which is of almost equal importance to both the physician and the surgeon; for which reason, and especially in a prophylactic point of view, it will be advisable to give a brief life history of its more remarkable members. In addition to the characters they possess in common with all the platylmia, the tæniada may be distinguished by the following. They have neither mouth nor intestine; and in the mature or sexual condition are united into a continuous band or chain, originating in an individual or zooid, which itself never reaches sexual maturity, but continues to throw off a succession of buds or gemmæ, each of which becomes a perfect hermaphrodite individual, though remaining attached to the colony of which it forms a link, for a considerable length of time. The separate zooids constituting this compound growth, or *strobila*, become more and more developed as their distance from the primary joint increases, until, having reached full maturity, they are successively detached, either spontaneously or accidentally, and pass out of the body with the fæces. The primary zooid remains all the time attached to the intestinal mucous membrane of the host by one or other of the organs mentioned above. This individual is termed a *scolex*, and each separate joint or sexual zooid budded from it a *proglottis*. This is the condition of the entozoon when it forms what is termed a *tænia*, or tape-worm, which consequently must be taken to represent a chain or continuous succession of distinct zooids gradually arriving at sexual maturity, and then thrown off. In this state it is always found within the intestinal canal, or, as in some fishes, in diverticula from it. In another condition, however, the tænioid entozoa are invariably found in the parenchymatous tissues of the body external to the intestinal tract; but here they exhibit a totally different aspect, constituting, in fact, the so-termed *cystica*, or cyst-worms. It is also a remarkable circumstance that, so far as is known, with the exception of the human subject, the tænioid and the cystic states of the same species are never found in the same animal. The cyst-worms of one animal give rise to tape-worms in another, and *vice versa*; and what is equally remarkable is the fact that these are in almost all cases reciprocally herbivorous and carnivorous or omnivorous species. As, for instance, the cyst-worm of the sheep or rabbit will produce tape-worms in the dog and cat, those of the pig and ox become tape-worms in man, &c. This curious state of things arises in the following way: The mature proglottis of the tænia is filled with ova, each of which, within a firm and peculiarly resistant shell, contains a minute active embryo, which, from its being armed with six hook-like boring implements, has been termed a 'six-hooked embryo,' or 'hexacanthus.' For the exclusion of this embryo, it appears, from repeated observations and experiments, to be necessary that the ovum should be subjected to the solvent action of the gastric juice in the stomach usually of another species of animal than that in which the proglottis was nurtured. But when thus liberated from its durance the 'hexacanthus' speedily makes its way through the walls of the intestine of its new host, and effects a lodgment in the tissues of the body, after a migration of greater or less extent. Having reached its ultimate destination, the hooks are thrown off, and the embryo is transformed into a cyst-worm, which differs according to the species of tape-worm from which it originated. This is the general mode of proceeding in the tæniada; and it will consequently be seen how the cystica, which were formerly regarded as a distinct class, are nothing more than one phase in the life-cycle of the tæniada. The only apparent exception, as yet observed, to the rule, that for the exclusion of the active embryo the ovum containing it must pass through the stomach of an animal, is that of *Bothriocephalus latus*, in which it would appear that the embryos are capable of living in water, after escaping from the ovum, in the form of a ciliated infusorium or planula; and it is a curious circumstance that in this species the egg-shell is furnished with a sort of movable lid to facilitate the escape of the embryo.

The various forms of cyst-worms have received the generic names of *Cysticercus*, *Cœnurus*, *Echinococcus*, and *Anthrocephalus*; and it is with the tæniada in this phase only that we have here much concern, the tape-worms themselves coming more properly under the notice of the physician.

(1.) The cystic-scolex of the common tape-worm is the *Cysticercus cellulosæ* of authors. The most usual habitat of this species is the muscular tissue of the pig, which when thus affected is said to be 'measly.' It is frequently met with, however, in other situations and in

other animals, especially in man. It is distinguished by its quadrangular head, short neck, thickened anteriorly, its long cylindrical body, and elliptical caudal vesicle, which, when the worm is lodged in the muscles, has its long diameter in the direction of the fibres. Nothing very positive is known respecting the earliest stages of the development of the 'six-hooked embryo,' as it does not appear by any means quite certain that the peculiar elongated cysts in muscle first noticed by Hessler, and afterwards more fully described by Mr. Rainey,¹ have any actual relation to this *Cysticercus*.

In the earliest stage at which it has been positively made out the worm is about 1 millimètre in length, and nearly spherical in shape. It is formed at this time simply of a minute vesicle, whose walls exhibit a distinct and rich plexus of vessels, within the smaller branches of which vibratile tags are visible, whilst the interior of the vesicle is filled with a clear fluid. On one part of the wall the rudiment of the head or future scolex may be seen as a small opaque spot. The development of this part gradually proceeds, until at length it attains its full size and projects into the interior of the large cyst, invaginated as it were, in a sac formed from the internal layer of the cyst. At first the 'head' is straight; but as it increases in size it becomes bent at nearly a right angle, and eventually at its lower or inner extremity the characteristic acetabula and hooks of the *Tænia* make their appearance. The entire course of development up to the completion of the cysticercal condition appears to require between two and three months. How long the parasite may remain in this stage within the tissues of its host is unknown, though it would appear from the observations of Stich² not to exceed a few years at most.

Though comparatively rare among ourselves, it seems that in some countries the occurrence of *Cysticercus cellulose* as a human parasite is by no means uncommon. This difference it is not easy to account for, unless, with Leuckart, we admit the possibility of self-infection from the ova of the tape-worm, and consequently that a difference in habits of cleanliness or care may be followed by corresponding consequences. It is not improbable, however, that a greater frequency of occurrence of *Cysticerci* in the pig in any country will lead to a greater frequency of occurrence of the tape-worm in man; and the more especially so, when, as is the case in many parts of Germany, large quantities of pig's-flesh in an almost uncooked or raw state are consumed. As a proof of the frequency of *Cysticercus cellulose* in certain districts, we may mention that Rudolphi states that in his experience it was met with in about one body in fifty-six of those brought into the dissecting-room at Berlin; and it would seem that in many parts of Germany scarcely a year passes in any anatomical school without instances of its occurrence. These instances, however, have for the most part only been discovered after death; the presence of the parasite when lodged in the muscular tissue being, except in rare cases, apparently unattended with any symptoms.

The comparative frequency of *Cysticercus* in the different organs or tissues may be stated in the following order:—

The muscular tissue, or rather perhaps the inter-muscular connective tissue; the brain and eye; heart; lungs; liver; and, more rarely, the kidney and lymphatic glands. The spleen, and even the osseous tissue, according to Stich, are not exempt from its invasion; though with respect to the latter situation at any rate considerable doubts of its occurrence may reasonably be entertained. It may be observed, also, that in cases where *Cysticerci* are found in the muscular tissues, they usually exist in vast numbers; whilst in cases where they occupy other situations, they are usually few in number, or even solitary. As regards the human subject, it has been suggested by Leuckart³ that where the parasite has been found in considerable numbers, it has been in cases of what may be termed self-infection conveyed by the passage of a tape-worm or of a proglottis, or it may be of some ova alone, into the stomach. The not infrequent concurrence of *Cysticerci* in the tissues with tape-worms in the intestine affords, as he remarks, a strong proof of this. Von Gräfe relates that of thirteen individuals treated by him for *Cysticerci* in the eye, five were also infested with tape-worm. The fact, at any rate, points to the necessity of care, in persons so affected, not to infect themselves with the mature ova either externally or internally. For it is not improbable that the 'hexacanthus' may be liberated from the ovum by mechanical violence as well as by the solvent action of the gastric juice; and when thus liberated, it may be capable of making its way as easily through the membranes of the eyeball as of the intestine.

With respect to the symptoms produced by *Cysticercus cellulose*, it has been already said that when confined, as is most usual, to the muscular or subcutaneous connective tissues, the parasite appears to be wholly innocuous. The power even of the affected muscles is not notably impaired; and this is the case, it would seem, with the heart as elsewhere. Nor do the adventitious cysts in which the worm is lodged seem to be liable to spontaneous inflammation, though instances are recorded of their becoming inflamed and suppurating in consequence of pressure or external injury in exposed situations, as on the extremities, nates, &c.

It is far otherwise, however, when the entozoon has penetrated into the eye or brain. Passing over, here, the symptoms arising from its presence in the latter situation, we will refer more particularly to the morbid phenomena produced by it in the organ of vision. For our knowledge of this subject we are chiefly indebted to Professor von Gräfe, who seems to have enjoyed abundant opportunities of studying it. His papers will be found principally in the

¹ *Phil. Trans.* 1857, p. 111.

² *Annal. d. Charité Krankenhaus*, 1854, p. 170.

³ *Mensch. Parasit.* p. 281.

Archiv für Ophthalmologie for 1857. In the eye the *Cysticercus* presents itself in two different conditions, free and encysted. The former occurs only in the aqueous chamber, or in the crystalline body, or rather its capsule; and it is considered probable that these free embryos have escaped into those situations from cysts originally lodged in the coats, and especially in the iris or choroid. Occasionally, however, when in the crystalline lens, the vermicule becomes surrounded with a secondary cyst. The changes and injurious effects produced vary, of course, according to the situation occupied by the *Cysticercus*. In the subconjunctival connective tissue its presence is rarely manifested by any symptom beyond occasional slight conjunctivitis. But when lodged in the aqueous chamber the consequences are more important; for not only does it directly hinder the free passage of the rays of light, but the irritation caused by it is often accompanied with a chronic inflammation of the surrounding membranes. And the effects when in the deeper parts of the organ are still more serious. Here it may be lodged, enclosed in a capsule, either beneath the retina or in the vitreous humour. It is probable that it always makes its way through the retina to reach the latter situation. The presence of the parasite on or near the retina and choroid induces chronic inflammation and disorganisation of those important parts, eventually leading even to total blindness.

The objective signs of the presence of a *Cysticercus* in the eye are extremely obscure without the aid of the ophthalmoscope. But with the aid of that instrument the parasite may be detected in the bottom of the globe, where it appears in the form of a light-coloured or semi-transparent vesicular swelling, whose position with relation to the retina may, in some cases, be determined by the appearance of the capillary vessels. When the cyst is covered in front by the retina, the vessels of that coat will be seen coursing over the little swelling; but when it is lodged in the vitreous humour or on the inner surface of the retina, the vessels, it is said, will be seen to terminate suddenly as they pass behind the tumour. The prognosis, in most cases, will be more favourable in the latter case than in the former.

(2.) *T. echinococcus*.—Another and far more familiar tænioid entozoon is that of which the *Acephalocyst* and *Echinococcus* represent the cystic and scolecid conditions. The tænia or strobila of this species is at present known to occur only in the dog and wolf. It is of small size, and usually exists to the number of many thousands among the villi of the small intestine, where the tæniæ are rendered apparent by the white colour of the mature proglottides.

The ordinary form in which this entozoon occurs in the human subject is that of a semi-transparent globose vesicle, with highly-elastic laminated walls, lined with a finely-granular layer, and which is lodged, sometimes in great numbers together, in the parenchyma of the liver, lungs, or other solid viscera, or in the connective tissue in almost any part of the body usually enclosed in a distinct capsule formed by exudation into and the consolidation of the surrounding tissue.

Hydatid cysts are capable of multiplying themselves in other ways; and it is to this property that their destructive power is mainly due. Although an individual cyst may singly attain to enormous dimensions, it is more from their rapid and continued propagation that the large hydatid tumours, and consequent great mischief caused by them, are produced. This multiplication takes place by what may be termed a sort of gemmation or proliferation in the walls of the cyst; and it is effected in two or three different ways. (1) The secondary cysts arise in the substance of the walls of the parent hydatid; and when they have reached a certain size become detached, and are then capable of independent growth, and of again themselves throwing off similar buds; and so on *ad infinitum*. (2) The secondary cysts may be protruded and thrown off either on the exterior or into the interior of the parent vesicle. In the former case we have the exogenous form of hydatid, or the *E. scoleicipariens* of Küchenmeister; and in the latter is produced the well-known endogenous or 'pill-box' hydatid of authors. Both forms occur in the human subject, though the latter by far the more frequently, and they may both even be found in the same subject. In either case the multiplication is sometimes carried to an enormous extent, and yet in the whole number of hydatids not a single *Echinococcus* will be found. Professor Leuckart mentions a case of a woman about sixty years of age who had a tumour for many years, which was supposed to arise from an extra-uterine foetation, but on examination after death was found to be caused by a colossal acephalocyst springing originally from the liver, but which had gradually filled the abdomen with a sac weighing with its contents about thirty pounds. In its interior were many thousands of secondary cysts, from the size of a pea to that of the fist; but not a single 'head' or hooklet was anywhere discernible.

Acephalocysts with several hundreds of secondary cysts are not uncommon; but usually the number of the latter is under a hundred, and generally perhaps from twenty-five to fifty.

(3) A third modification in the mode of development, or rather of multiplication of hydatids, has been described under the name of *E. multilocularis*. In this form the cysts never attain to anything like the dimensions of the two former, rarely exceeding those of a millet-seed, or at most of a pea. But though of these small dimensions, the cyst is capable of producing compound growths of considerable size, consisting of aggregations of vesicles imbedded in a common stroma. When a mass of this kind is cut across, it presents in the interior innumerable minute cavities of irregular form, separated by condensed connective tissue, and containing a tolerably transparent gelatinous material. Running amongst them may be seen the atrophied remains of the bile-ducts or blood-vessels, &c. Growths of the kind have hitherto been observed only in the liver; but as there appears to be no reason why they should not occur elsewhere, it may be useful to advert a little further to them. The

alveolar structure and the gelatiniform nature of the contents of the cysts naturally led observers at first to suppose that they constituted a form of colloid cancer, the occasional presence of echinococcus heads or hooklets being deemed a merely accidental complication. Virchow,¹ however, has clearly pointed out the correspondence between the so-termed colloid masses and minute echinococcus-cysts. His observations have since been amply confirmed by Professor Leuckart,² who has fully satisfied himself that all the cysts, down to the smallest, present the well-known characters of the common acephalocyst. He, moreover, ascertained that the echinococcus-heads contained in them were identical with those found in the usual hydatids, and that the multiplication of the cysts followed the type of *E. altricipariens*.

The connection between the hydatid cysts and the tænia, from which they are derived, hardly requires to be here pointed out, after what has been said on the general mode of development of the tæniada. The strobila in the intestine of the dog throws off proglottides containing the mature ova, which, on passing into the stomach of another animal, liberate the enclosed embryos, which make their way through the walls of the intestine, penetrating either directly into the contiguous connective tissue, or into the blood-vessels, by which they may be conveyed through the branches of the portal system into the liver, or through other channels into all parts of the body. Hydatids consequently, even to a far greater extent than *Cysticerci*, may be found in any part and in any of the tissues, including the bones themselves. In some respects, however, the two forms of cystic worms seem to affect different tissues by preference. The most common seat of the *Cysticercus* is, as has been said, the muscular system—a situation in which acephalocysts rarely occur. The eye and brain, also, are more rarely invaded by acephalocysts than by *Cysticerci*. By far the most common situation for hydatids in the human subject is the liver. In other situations, out of nearly 200 cases, Professor Leuckart states that in about 40 the lungs were the seat of invasion; in 30, the muscular and subcutaneous connective tissue; in 30, the kidneys; in 26, the lower pelvis; in 20, the nervous centres; in 17, the bones; and in 10 the heart. In the remaining 17 the parts invaded were the orbit, eyeball, mouth, thyroid body, walls of uterus, &c. In general, in man, hydatids are confined to a single locality, though this is by no means always the case.

The frequency of occurrence of hydatids appears to vary much in different parts of the world. In this country, and in Europe generally, they are but rarely met with; whilst in Iceland it would seem that one-fifth or one-sixth of the entire population suffers from their invasion. In any case the poor appear to be more often affected than the rich—a circumstance easily explicable by their different habits.

The growth of hydatid tumours, when, from their external situation or from other circumstances, their existence is early manifested, appears to be extremely slow. Thus Velpeau removed a hydatid tumour from the axilla, which in six months had only reached the size of a walnut; and, in another case, the tumour had attained the size of the fist in about a twelvemonth. The endogenous or 'pill-box' hydatid is probably slower of growth than the other varieties, although in process of time it may acquire far greater dimensions. The ill effects of a hydatid growth vary, of course, according to its site. The more important situation in which tumours of this kind present themselves to the surgeon's notice are in the liver, eye, bones, and in external situations in any part of the body. A not unfrequent situation, also, is the lower pelvis, where by its growth the tumour may so far impede the functions of the bladder, uterus, or rectum, as to call for operative interference. The diagnosis, however, of such cases is extremely difficult, as similar symptoms may, as is obvious, arise from tumours of almost any kind in the same situation. The distinction, perhaps, might be drawn more from collateral circumstances or negative proof than from any positive symptoms. When developed in the interior of a bone, the signs of a hydatid growth would be equally obscure until the tumour had reached considerable dimensions, or an exploratory opening had perhaps been made.

When it occurs in the eye, the effects of an acephalocyst would be much the same as those produced by a *Cysticercus*, except that as the growth of the latter is far more rapid, the ill consequences of the parasite are slower of development in the one case than in the other. The distinction during life, however, would be extremely difficult, and of no practical importance.

Although the duration of hydatid tumours is generally very prolonged—in fact lasting for the whole of life—it not unfrequently happens that they die, as it were, at an early period, and either cause suppuration, and are thus discharged, or become cretified and wholly innocuous.

The best treatment of a hydatid tumour appears to be that of making a free opening into it, so as to give exit to the contents and a vent to any subsequent discharge. In cases of hydatid tumour of the liver, it has been proposed, and the proposal has been occasionally carried out with success, to make the incision at two intervals when there was reason to suppose that no adhesion existed between the wall of the abdomen and the coverings of the cyst. But in the majority of cases it will, perhaps, be better to wait until there is fair reason to conclude that adhesion has been set up. The injection of the cysts with various solutions, as of iodine, perchloride of iron, nitrate of silver, &c., has been practised; and some have thought with good effect. As the wall of the cavity containing the acephalocysts is in some respects analogous to those of a chronic abscess, the closure of the cavity when emptied will take place in the same way as in the case of an abscess.

None of the other species of Tæniada infesting man require any observation here.

¹ *Das Alveolar-Colloid der Leber*, Tübingen, 1854.

² *Op. cit.* p. 373.

II. *Trematoda*.—The Trematoda, in many respects allied to the Tæniada, differ from them in the possession of a distinct alimentary canal, with a mouth, but without any anal opening. They are also always solitary, and never associated into compound growths. They are for the most part hermaphrodite, though in some cases the sexes appear to be distinct. As in the Tæniada, the vitellus is furnished by a distinct vitellarium. In the course of their development, the Trematoda, like the Tæniada, present several phases, and require for its completion to migrate from one animal to another. Unlike the Tæniada, however, with the probable exception of *Bothriocephalus*, the larval forms of the Trematoda are enabled to live, probably for a long time, and to enjoy active powers of locomotion, external to the body of an animal, into which also they are capable, in many cases, of making their way through the integuments. They thus form, as it were, a link between the parasitic and non-parasitic scolecidæ, having relations on one side with the Turbellaria, and on the other with the Tæniada. The course of development of a trematode may be thus briefly described:—From the ovum, generated in the mature fluke, is produced a ciliated embryo or planula, which, after remaining in the water for some time, is converted into an elongated vermiform creature, sometimes termed a ‘redia,’ which in some cases possesses a tolerably well-developed alimentary tube and a distinct opening for the exclusion of the young; whilst in others it is reduced to a simple elongated tube, with no visible trace of internal organisation, and immobile. Within these rediæ or cercaria-sacs are produced, by a sort of internal gemmation, numerous minute tadpole-like creatures (*Cercariæ*), which, when liberated, swim actively about until they meet with a suitable ‘host,’ into which they bore their way, casting off the now useless caudal appendage.

Although some such cycle as this has been clearly traced in several species of Trematoda, nothing of the kind has as yet been ascertained with respect to those infesting the human frame. It is only from analogy that these have been supposed to undergo similar changes. Whether the sheep, in which the liver-fluke is so extremely frequent, become infected by swallowing with the grass they feed upon snails into which the cercariform larvæ of a *Distoma* had entered, or whether they receive the *Cercariæ* in the water they drink, as is perhaps more likely, has not as yet been made out.¹ Nor is there anything further known as to the mode in which flukes enter the human body.

About nine species of trematode entozoa are recorded as occurring in the human subject: ²—

1. *Fasciola hepatica*, Linn. (*Distoma hepaticum*, Aut.)
2. *Distoma lanceolatum*, Mehlis.
3. „ *crassum*, Busk.
4. „ *ophthalmobium*, Diesing.
5. „ *heterophyes*, Von Siebold.
6. *Bilharzia hæmatobia*, Cobbold.
7. *Tetrastoma renale*, Delle Chiaje.
8. *Hexathyridium pinguicola*, Treutler.
9. „ *venarum*, Treutler.

Fortunately, however, most of this formidable list are of very rare occurrence, and the majority have been met with only once or twice. One or two only among them offer any points of interest to the surgeon.

(1) *Fasciola hepatica*.—The common liver-fluke of the sheep has been met with in the human body less rarely perhaps than any of the rest; but even of its occurrence not more than nine or ten cases are recorded. It was found in the gall-bladder by Mr. Partridge; and in the liver itself, or more probably in the biliary ducts, by Bidloo, Weper, Pallas, Brera, and Mehlis; in the duodenum, by Brera; and several together in the portal vein and its branches, by M. Duval. Three apparently well-proved cases of the occurrence of the liver-fluke in subcutaneous abscesses have been recorded. In one instance, related by Giesker and Frey,³ the abscess was in the sole of the foot; in another, related by ourselves,⁴ a living *Fasciola* was extracted by Mr. Charles Fox, of Topsham in Devonshire, from an abscess behind the right ear. A third case is reported by M. Dionis des Carrières,⁵ in which the fluke was extracted from a tumour in the right hypochondrium. The swelling was about the size of a pigeon’s-egg, and excessively painful, hard, and at first deep-seated. A fourth instance of the same kind, but perhaps not so thoroughly authenticated in all respects, though we ourselves see no reason to doubt it, was communicated to Prof. Owen by Dr. J. Penn Harris of Liverpool.⁶ In this instance several flukes were said to have been found in an abscess under the scalp. One peculiarity in all these cases consists in the tendency the abscesses showed, after they had been opened, to close and become refilled.

(2) *Distoma ophthalmobium*, Diesing (*Monostoma lentis*, Nordmann).—In the eyes of several species of fish a peculiar trematode parasite, termed *Diplostomum volvens*, was discovered by Von Nordmann, and has been excellently described and figured by him.⁷ Prof. Jüngken⁸ extracted a lens in a state of incipient cataract, in which he found eight minute

¹ Mr. A. P. Thomas has lately shown that in all probability the amphibious snail *Linnæus truncatulus* is the only true intermediate host of the liver-fluke in sheep; and that the use of common salt in the food is a certain prophylactic and excellent remedy.

² Dr. Cobbold, *Proc. Zool. Soc.* 1862.

³ *Mittheilungen der Naturforschenden Gesellschaft in Zürich*, 1850, ii. p. 89.

⁴ Küchenmeister, *Manual of Parasites* (Sydenham Society’s translation), vol. i. Appendix, p. 434.

⁵ Davaine, *Traité des Entozoaires*, p. 320.

⁷ *Mikrographische Beiträge*, p. 28, pl. i. figs. 1–3.

⁶ Küchenmeister, *op. cit.* Appendix, p. 435.

⁸ Küchenmeister, *Manual*, &c. vol. i. p. 245.

trematoda, which were referred by Von Nordmann to the genus *Monostomum*. And Gescheidt¹ found in the eyes of a child five months old, affected with congenital cataract, between the lens and its capsule, four specimens of a *Distoma* $\frac{1}{4}$ to $\frac{1}{2}$ a line in length, some of which exhibited signs of vitality thirty-six hours after the death of the child. Dr. Cobbold considers that 'all these circumstances render it probable that the worms extracted by Professor Jüngken were specifically identical with those removed by Gescheidt.'

What relation these trematoda have to that of the fishes' eye, or what their origin and life-history may be, is at present wholly unknown.

(3) *Bilharzia hæmatobia*.—This minute filiform species, which is not more than three to four lines in length, is distinguished among its congeners by its being bisexual. It appears to be extraordinarily abundant in Egypt, having been noticed by Griesinger 117 times in 363 bodies. Its primary habitat seems to be in the portal-venous system, and it is especially common in the minute veins in the walls of the urinary bladder. Its presence in the latter situation is indicated after death by circumscribed patches of inflamed and thickened mucous membrane, and by tenacious viscous greyish-yellow exudations, in which the ova of the entozoa are lodged. The ova are also sometimes found free in the urine, and thus afford a ready means of diagnosis. The vascular spots are sometimes raised into pedunculate excrescences one to three lines high, and having a fungous or verrucose appearance. The inroads of the worm are, however, not always limited to the bladder, but may extend to the ureters, or even as far as the pelvis of the kidney itself. When the ureters are affected, the thickening of the submucous tissue may produce such a constriction of the canal as to cause retention of urine above it, and thus to lead to dilatation of the pelvis, and ultimately to disorganisation of the gland. The aggregations of ova not unfrequently also constitute the nuclei of calculous deposits; and this appears to be the nature of the lithiasis of the Egyptians, described by Prosper Alpinus.²

It is proper here to notice a peculiar cutaneous affection, occasionally very prevalent amongst British troops in India, and more especially at Delhi, whence the affection in question has been named the 'Delhi-boil,' though not in reality having any furuncular character whatever. It is not, however, confined to that city, having been observed in many other and widely remote localities, as in Scinde, and at Lahore, Agra, Meerut, Roorkee, Mooltan, and elsewhere.

Though well known, and often discussed, the true nature of this affection has hitherto never been satisfactorily explained. But in the 'Report of the Army Medical Department' for 1868 (pp. 319–321) are two papers, by Staff-Assistant-Surgeon J. Fleming and Staff-Surgeon-Major A. Smith, whose observations strongly tend to show that the 'Delhi-boil' is caused by the invasion—probably, as suggested by Mr. Smith, through the sudoriparous pores—of a parasitic organism; and it would seem by no means improbable that this may be referred to some species of *Distoma* or other Trematode, in the cercariform or embryonic condition. Furthermore, it appears to be pretty conclusively shown that the parasite is conveyed through the medium of the well or tank water used for the purposes of ablution—a remarkable circumstance corroborative of which is cited by Mr. Smith in the fact 'that scarcely a single dog belonging to the military which may have been for any length of time in Delhi, escapes contracting the disease on the tip of the nose.' The affection, as described by Assistant-Surgeon Fleming, 'is a morbid growth affecting the skin and subcutaneous tissue, which after a time ulcerates, but is unattended, until ulceration has commenced, with any inflammation. It commences very like a mosquito-bite, the little red spot increasing slowly in size with a well-defined border, and raised above the surrounding skin. The growth continues to spread for two or three weeks or more, and as it progresses it becomes more elevated and covered with tortuous dilated vessels. A vesicle at length forms at the summit which discharges a pale yellowish serous fluid. Ulceration then commences and proceeds centrifugally until the whole growth is destroyed. The ulceration sometimes even extends to the neighbouring structures, and if the ulcer is situated near the eyes, nose, or lips, those parts will almost be sure to be destroyed or materially injured, not excepting the cartilages of the nose. During the growth of the tumour it has a transparent and shining aspect, and if examined with a lens exhibits one or more yellowish spots, deeply seated about the centre of the tumour. If one of these spots be cut down upon with the dissecting needle, a small circular yellowish body with a glistening capsule may be easily removed.'

Dr. A. Smith describes the affection rather differently, but there is no difficulty in reconciling his description with that above given.

From the description and figures contained in these two interesting reports it is impossible to come to any positive determination respecting the true nature of the supposed organisms found in the 'boils,' but the subject is one well deserving investigation; for should the views of Surgeons Fleming and Smith be confirmed, there could be no difficulty in the devising of such prophylactic measures as should entirely, or almost entirely, prevent the occurrence amongst our troops of this troublesome and, as it would seem, sometimes serious malady.

III. The NEMATODA, or Thread-worms, and the GORDIACEA, or Hair-worms, together with the Acanthocephala, constitute the sub-class Nematelmia.

Numerous entozoa belonging to this sub-class have been mentioned as occurring in the human subject, of some of which the following is a list:—

¹ Ammon, *Zeitsch. f. Ophthalmol.* iii. No. 4.

² Küchenmeister, *op. cit.*, &c. vol. i. p. 285.

1. *Ascaris lumbricoides*, Linn.
2. " *mystax*, Rudolph.
3. *Trichocephalus dispar*, Rudolph.
4. *Trichina spiralis*, Owen.
5. *Filaria* (*Dracunculus*) *medinensis*, Gmelin.
6. " *lentis*, Diesing.
7. " *bronchialis*, Rudolph.
8. *Filaria cystica*, Salisbary.
9. *Strongylus gigas*, Diesing.
10. *Sclerostoma duodenale*, Von Siebold.
11. *Oxyuris vermicularis*, Bremser.

In this list, however, not more than four or five demand any notice here, the remainder being for the most part exclusively intestinal parasites. We shall notice only—

1. *Trichina spiralis*.
2. *Filaria medinensis*.
3. " *lentis*.
4. " *cystica*.
5. *Oxyuris vermicularis*.

(1) *Trichina spiralis*.—Although, strictly speaking, this worm is scarcely likely to become the subject of surgical treatment, yet, as it may not unfrequently come under the surgeon's notice in the course of operations, and appears also occasionally to be productive of local symptoms, or to require exploration by surgical means for its detection, it may not be wholly out of place to take some notice of it.

The entozoon may be regarded as peculiar to the voluntary muscular system. The muscles affected with it are seen on section, or even without, to be studded with innumerable minute yellowish-white specks of an elliptical form, the long diameter corresponding with the direction of the fibres. Each of these specks on examination will be found to contain a minute vesicle, in which is a coiled-up vermicule about one millimètre in length when stretched out. The cysts themselves vary somewhat in size, and are about one-third of a millimètre long. The cyst appears to belong to the worm itself, and not to be the product of any exudation in the surrounding tissue. *Trichinæ*, however, may exist in the unencysted condition in the flesh of animals without being visible to the naked eye, and even the cysts, especially before cretification has commenced, may easily escape detection without the aid of a lens.

It has been pretty satisfactorily proved that the chief source of the introduction of *Trichinæ* into the human system is the eating of trichinous flesh, more particularly that of the pig, and more specially if the meat is raw or badly cooked. Even if in the form of sausages or hams—unless these have been long made and well smoked—the flesh of the pig when trichinised appears to be capable of communicating the germs. The vermicules are exceedingly tenacious of life, and retain their vitality even in decomposed meat, and after long immersion in water, or even in glycerine; and the cysts are so constituted as to be unaffected by moderately strong acids.

One of the most remarkable features of *Trichinæ* is the rapidity of their development. A very few days after the ingestion of trichinised meat the vermicules exhibit sexual distinction and maturity, rapidly produce their ova, from which while still within the parent the embryos are liberated, and commence active migration on their own account. This they effect by perforating the walls of the intestine and making their way to the voluntary muscles, where they become encysted, and thus complete the cycle of their existence. The whole process is apparently concluded within a single month, or even less. The genesis and migrations of *Trichinæ* are therefore astonishingly rapid, and it is no wonder that the sudden invasion of such a host of foes should occasionally give rise to grave disturbance in the system.

The invasion is often attended with a singular febrile affection presenting most of the characters of acute rheumatic fever, from which it is mainly distinguished by the absence of any articular affection. Local swellings of the muscles, especially of the calves of the legs, have been observed; and in doubtful cases an exploratory puncture and the abstraction of a minute portion of the muscle have been employed to settle the diagnosis.

(2) *Filaria medinensis*.—The well-known *Dracunculus*, or Guinea-worm, is perhaps the most important, in a surgical point of view at any rate, of all the human entozoa. Although the greater part of the world is happily exempt, except occasionally, from its attack, in those regions in which it is endemic the guinea-worm may justly be regarded as one of the most pernicious pests to which mankind is exposed. Fortunately it appears, strictly speaking, to be indigenous in only a comparatively limited portion of the north tropical and subtropical zones; its geographical centre of diffusion being the continent of Africa south of the Great Desert, and north, as it would seem, of the equator. From this centre, however, it spreads more or less extensively into the contiguous parts of Africa, and to the opposite portion of Asia, extending as far north as the borders of the Caspian and into Central Asia, though how far to the east is uncertain. It is common in many parts of the Indian Peninsula, but more especially towards the west. The abundance of its occurrence in countries beyond the continent of Africa would seem, in fact, to bear some proportion to the amount of their direct communication with the Negro races. For the same apparent reason it has become established in some of the West India Islands, and especially, it is said, in the island of Curaçoa; and also

on the continent in Demerara, and other parts of the mainland of tropical America. But, although a certain geographical range may thus be assigned to the guinea-worm, it is nevertheless met with occasionally in all parts of the globe, and in individuals of every race; the only condition apparently necessary being that they should have visited some of the parts comprised in its endemic range within a certain period. It is consequently not unfrequently brought under the notice of the surgeon in this country and elsewhere; and as the effects produced by it are sometimes very grave, the subject of the guinea-worm is one of some importance to him.

Not to enter at too great length into the natural history of the worm, it is essential to remark that from what is known of it there is every reason to conclude that the parasitic condition represents but one phase of an existence some portion of which must be passed external to the human or any animal body. This circumstance leads to the consideration of the relations of the guinea-worm to other allied forms. Here we are at once struck with the close resemblance in many respects between its habits and those of several species of *Gordiacea*, or hair-worms, which at one period of their existence are found in the interior of insects or other animals, or even of grain. Several species of *Gordius*, *Mermis*, &c., are known, whose ova are deposited in water or moist earth; the embryos produced from which make their way into the bodies of aquatic or other insects, or of water-fowl, and there become developed into worms, often of considerable length. In the case also of the *Anguillula* of wheat, the larva, according to Davaine,¹ is known to exist for several months in water, and also to be able to endure complete desiccation for even several years without perishing. From these, therefore—and many more similar cases might be cited—we see that there is nothing unusual in the conditions we have presumed to obtain in that of the guinea-worm.

One important conclusion, in a practical point of view, to be drawn from this observation, is that the guinea-worm cannot propagate itself directly in the tissues of its 'host.' It is *absolutely necessary for its multiplication that it should pass through some stage of existence external to the body.* And as this stage of existence may be supposed to demand conditions met with only in certain regions, but with which we are not at present fully acquainted, an apparent reason is thence afforded for its limited geographical range.

In its parasitic stage the guinea-worm, when it has arrived at maturity—that is to say, when it contains active embryos of the full size—varies in length from about two feet, or less, to six feet or even more, if we are to believe some accounts. It appears to be usually shorter, or to arrive sooner at maturity perhaps, in Bombay than is observed in this country in the case of worms contracted on the coast of Africa. In the former locality the length appears to be about three feet; whilst from the latter, so far as our own observation extends, it is seldom less than six. It is cylindrical in form, and nearly white when quite fresh. The surface is smooth, although under a magnifying-glass it is seen to be marked with fine irregular circular rugæ. It is very tough and elastic, to which property, perhaps, more than to any muscular contraction, is due the retraction of the worm when suddenly broken off. In structure it may briefly be described as an elongated tube, open at one end only, and whose walls are constituted by an external integument, strengthened by four longitudinal muscular bands; whilst the interior is lined by the enormously dilated uterus, whose wall is scarcely distinguishable from the common parietes; between the two, however, runs a slender and inconspicuous intestinal tube. The mouth is a simple minute circular pore, around which are placed four minute papillæ; and there is no anus. The internal cavity consequently represents the interior of what, were the animal sexual, would be the uterus. As it is, it is more properly comparable with the 'redia' of a trematode, seeing that it produces, by a sort of gemmation, as it would seem, innumerable embryos, which are usually found in an active state in the midst of a grumous or pultaceous substance, and in all stages of development. The full-sized young are about the forty-second part of an inch in length, fusiform in shape, and tapering off rather suddenly into a slender elongated caudal portion. Internally they present traces of an intestine, which terminates, according to some, in an anus at about the junction of the middle and hinder thirds. Vestiges of other organs may also be discerned, to which it is needless here to refer. These minute creatures, when first extracted from the maternal body, are very active and vivacious when placed in warm water; they are also extremely tenacious of life, being capable, as shown by experiment, not only of living for many days in damp earth, but of enduring complete desiccation for a considerable time. The mouth of the young *Filaria* is merely a simple pore, and they have apparently no organs fitted for boring into animal tissues. The great similarity between these young guinea-worms and certain microscopic *Filaridæ*, and especially one species amongst them named by Dr. H. Carter *Urolabes palustris*,² has induced that excellent observer to consider it highly probable that they are identical. The species in question abounds in the mud of tanks and ponds about Bombay; and Dr. Carter relates many circumstances in support of his belief, that it is by the entrance through the integument of these minute *Filaria* that the guinea-worm effects its lodgment in the body. He further thinks that the young *Filaria* enter through a sudoriferous duct, or a hair-follicle. Observation, however, has yet to show the true relation between these unarmed aquatic *Filaridæ* and the entozoon. In our view of the case probability would seem to be in favour of the notion that the *Filaridæ* in question do not themselves represent the future parasite; but

¹ 'Recherches sur l'Anguillule de Blé niellé,' in *Mém. de la Soc. Biol.* 1856.

² *Annals and Mag. Nat. Hist.* 1859, vol. iv. p. 32.

that the active embryos of the latter, finding their way into the water or mud, develop sexual organs and produce ova, the embryos proceeding from which may or may not have a filariform aspect, and may or may not be furnished with some boring apparatus, but which, as in the case of *Mermis* and *Gordius*, enter the human body and become the guinea-worm, which would thus correspond to a 'nurse' or 'redia,' as before remarked, and as was suggested by ourselves in 1846.¹ The male guinea-worm is at present quite unknown, and it will probably be found under a distinct guise from that of the female. It may be, and probably is, infinitely more minute than its mate, upon which it may even be parasitic, as in the remarkable case of the gordiacean entozoon of the humble-bee, *Sphærulearia bombi*, described by Sir J. Lubbock.²

The above brief account of the natural history of the guinea-worm will serve merely to give an idea of the direction in which prophylactic measures are likely to be successful. Whether Dr. Carter's supposition be exactly correct or not, it is abundantly proved that the infection of guinea-worm is conveyed directly from without, through the integuments in the neighbourhood of the parts in which it is found lodged. The notion entertained by some that it may be introduced through drinking water seems to us to be devoid of sufficient evidence in its support.³

Symptoms and effects of guinea-worm.—The entrance of the worm into the body, however effected, is unattended with any observable symptom: and even when fairly lodged and growing rapidly in the tissues, the person affected is wholly unconscious of its existence until the period when it is ready to make its exit, or rather to discharge the cargo of embryos with which it is crammed.

The life of the worm as a parasite may consequently be divided into two periods, in one of which it is latent, and in the other manifests its presence by external signs.

The latent period would seem to vary considerably in duration, if we can rely upon all the reported cases; but in our own experience, which has been considerable, of cases as they occur in the country, the period is from ten to eighteen months, seldom less or more, and usually about twelve. During this period the worm appears to wander about in the cellular tissue, and probably in most cases at some depth from the surface; but this of course will vary according to the part invaded. In one case in which a guinea-worm fully six feet long was accidentally discovered lodged in the deep cellular tissue of the leg around the tendo Achillis, and which occurred under our own observation, no morbid symptom whatever was exhibited during life, nor after death was there the slightest appearance of irritation in the surrounding tissue.⁴

When arrived at maturity, the worm makes its presence, and the place of its intended appearance known by various symptoms, such as itching and slight swelling, usually circumscribed, but sometimes diffuse, and which gradually assumes the aspect of an inflamed pustule or boil. These symptoms are, in some cases, attended with considerable constitutional disturbance, and with severe lancinating deep-seated pains; but this is by no means always the case. When left to itself, the worm invariably presents itself head first. On this account, unless an opportunity (which rarely occurs) be afforded of seeing the case before the pustule is opened, the head is usually destroyed. The after progress of the case depends very much upon, 1st, the general state of health or habit of the individual; and 2ndly, on the mode in

¹ *Microscopical Transact.* vol. ii. p. 65.

² *Linn. Transact.* vol. xxiv. p. 101, pl. 21, 22.

³ In 1846 (*loc. cit.* p. 74 *et seq.*) I suggested that the parasitic condition represented only one phase or stage of the life of the guinea-worm, not as an individual, but as a species; and that this parasitic form was preceded and followed by other forms, and that the embryos found within the asexual parasitic form, or *redia*, probably represent the immature condition of the sexual individuals, which arrive at their full development externally to the host. In partial confirmation of this view many analogous cases since made known might be cited; but as more particularly referring to *Dracunculus*, I would only advert to the views of M. A. P. Fedschenko, a lamented Russian naturalist, first published in 1870, as quoted by Dr. Cobbold (*Parasites*, p. 223, 1879). M. Fedschenko asserts that the embryos, after quitting the human host, bore their way into the bodies of a species of *Cyclops*, where in about twelve hours they change their skin and increase in size. Their larval development is completed in about five weeks. He supposes that then as perfected larvae they, with their crustacean hosts, are transferred to the stomach of the ultimate human bearer. Here it is surmised that sexual maturity is attained, resulting in the production of perfect males and females, of which the latter migrate to the situations in which the guinea-worm is found, whilst the males undergo the ignominious fate of being expelled with the faeces. In presumed confirmation of this proceeding, M. Fedschenko adduces the circumstance that he has witnessed the entry of embryo guinea-worms through the integument of the *Cyclops*. Now, to say nothing of the extreme difficulty of diagnosing a filamentary nematoid embryo with anything like certainty, it must be admitted that the whole account is based upon little more than mere conjecture; and as to the production of the mature asexual guinea-worm from the ingestion of infected Entomostraca, M. Fedschenko's experiments on dogs and cats wholly failed.

A certain amount of analogical support to this view may be found in such cases as *Cucullanus* in fishes, and *Trichina spiralis* in the human and other subjects, with respect to both of which entozoa there can be little or no doubt that the embryos liberated in the stomach or intestine migrate thence to all parts of the body. But in these cases the important difference should be borne in mind that the wandering embryos are innumerable, whilst in that of the guinea-worm usually not more than one or two, or, any rate, very few, mature parasites are met with. It is scarcely necessary to remark, on the other hand, that M. Fedschenko's observation of the actual penetration of a minute filariform embryo through the hard skin of a *Cyclops* is strongly in favour of the notion that similar filarians may be able to penetrate the human cuticle, more especially when soddened with water, or, as suggested by Mr. Carter, may enter through the sudoriparous ducts.

On the whole I remain of opinion that the mode of entry of the guinea-worm into the human body is most probably in the way suggested in the text.

⁴ The specimen taken from this case is in the Museum of the Royal College of Surgeons.

which the extraction is conducted. The latter proceeding is usually effected by winding the protruded portion of the worm round a piece of wood, quill, or bougie, day by day, so long each time as it yields to gentle traction. The animal is tolerably tough and highly elastic, as before said, and will consequently bear a considerable amount of stretching without risk; but, for the same reason, should the force employed be too great, the worm when broken is immediately withdrawn to a great depth. This event is usually followed by considerable deep-seated inflammation and suppuration, which is liable to be succeeded by extensive sinuses and sloughing of the cellular tissue, sometimes requiring long and deep incisions. In these cases there is reason to believe that the remainder of the worm has perished, and that the wide-spreading irritation is due to its presence as a dead and decomposing foreign body. In other cases, however, when the worm retracts in the same way, but in which it does not so perish, the original orifice may close up with little or no signs of irritation of the deeper tissues, and after a time the entozoon will show itself at another distant part of the surface in the same way as at first. In India it would seem that the more experienced native practitioners are skilful in cutting down upon the worm when near the surface, and are thus enabled to seize it by the middle, and to effect its extraction very speedily. It sometimes happens also that the entire worm may be coiled up close to the point of exit, and may thus be removed *en bloc*; but it is far more usual to find that the extraction is a long and tedious proceeding, demanding great care on the part of the surgeon, and considerable patience and fortitude on that of the patient.

(3) *Filaria lentis*.—Cases are recited of the occurrence of minute filariform worms in the orbit and within the eyeball itself. Some of these, and especially those in the former situation, may not improbably be instances of immature guinea-worms; whilst those met with in the interior of the globe would seem to belong to a different species altogether. Very few cases, however, of this kind are recorded. In three of these the minute *Filaria* was seated in the crystalline lens, or rather perhaps between the lens and its capsule; and in one its habitation was the anterior chamber. To this minute worm, about whose structure and natural history we have no further information, the name of *Filaria lentis*, or *oculi*, has been applied. It may perhaps turn out to belong to the genus *Trichina*.

(4) '*A Species of Undescribed Worm*,' Wucherer, 1866; *Trichina cystica*, Salisbury, 1868; *Filaria sanguinis-hominis*, Lewis, 1872; *Filaria Bancrofti*, Cobbold, 1876; *Filaria Loa*, Guyot.

Under one or other of the above names one or more species of filariform worm has been described by several writers as occurring in all parts of the world, and even in this country, by Mr. D. H. Gabb.¹ Besides the writers cited above, we are indebted for our knowledge of the parasite or parasites more especially to Dr. T. R. Lewis, Dr. Manson, and Dr. Bancroft.

If, with Dr. Cobbold, it be assumed that the different forms comprised under the term *Filaria sanguinis-hominis* or *F. Bancrofti* represent but different phases in the development of one and the same species, in Asia, Africa, Australia, and America, it may be described as existing under at least two distinct forms, of which one represents the embryonic stage or condition, and the other that of sexual maturity or full growth. It is highly probable, however, that there may be an intermediate and, at present, unknown form between these two.

In the former stage the *Filaria* is represented by a minute, actively-moving vermicule, whose dimensions, as stated by different writers, would seem to vary considerably, ranging from "005 to "013 in length. In general character these embryos resemble those of most other Filariæ, *Ascaris*, *Strongylus*, &c., and from which they would probably be hardly distinguishable.

Embryos of this kind were first observed in the urine, and even in the tears, and subsequently by Dr. T. R. Lewis in enormous numbers in the circulating blood, in which situation Dr. Lewis noticed that the human hæmatozoa differed from those found in the dog in the possession of a distinct sheath, or cyst, in which they were lodged. This observation was subsequently abundantly confirmed by other observers, and more especially by Dr. Manson in China and Dr. Bancroft in Australia.

In what is assumed to be the mature state, the *Filaria* takes the form of a very slender thread-worm, between two and three inches long and about 0'01 thick, and, like the guinea-worm, crammed in all parts with free embryos, germs, and undeveloped ova. This mature worm was first detected by Dr. Bancroft, who met with his first specimen in a 'lymphatic abscess' in the arm. This was dead, but afterwards four other specimens were obtained, living, from a hydrocele of the cord.

The precise relation, if there be any, between the mature *Filaria* thus found in different parts of the body in the tissues external to the blood or lymphatic vessels and the minute embryos, whose proper habitat would seem to be in one or other set of vessels, whence they escape into the urine, together with either blood or lymphatic fluid, does not appear to have as yet been quite satisfactorily traced throughout. Some light, however, has been thrown upon the matter by the curious and important observations of Dr. Manson, and afterwards of Dr. T. R. Lewis, on the ingestion by Mosquitoes of the hæmatozoa and the changes subsequently undergone by the embryos within the body of its insect host; changes which probably tend to fit the embryos to obtain their own livelihood in the outer world, where they may be supposed to attain sexual maturity and become ready when swallowed or otherwise introduced

¹ *Lancet*, June 22, 1878.

into the human body to make their way into the tissues and pour their offspring into the blood-vessels or lymphatics. But as regards this hypothetical transmigration much remains to be made out.

With respect to the morbid effects of the presence of the embryo *Filaria sanguinis-hominis*, if any are produced, which is by no means generally the case, they may all be referred more or less directly to affections of, or connected with, the lymphatic system and to such as it might be supposed would be produced by the obstruction of the lymphatic vessels. The principal affections that have been noticed as accompanying the presence of *Filaria sanguinis-hominis* are, firstly, *Chyluria* and *Hæmaturia*, which may be endemic, *Elephantiasis Arabum*, in all its forms, including 'Lymph-scrotum,' certain forms of hydrocele, lymph abscesses, &c., of which, however, perhaps the most constant are *Chyluria* and *Hæmaturia*.

It remains to notice one of the most extraordinary facts that have been made known in the life-history of this *Filaria*, and which will account in some measure for the circumstance that, while in Asia and in cases of *Chyluria* and the other lymphatic affections, hæmatozoa have almost invariably been met with, in South America, where similar affections appear to be equally abundant, their occurrence was for some time entirely overlooked. This circumstance admits of explanation from Dr. Manson's interesting observation that the hæmatozoa migrate periodically at regular intervals of twenty-four hours into and out of the circulating blood. He states that 'the young escape into the circulation at regular intervals of twenty-four hours, the discharge [into the blood] commencing soon after sunset and continuing till near midnight, from which time till the following noon their number gradually decreases. From two or four o'clock till six they are nearly absent [from the blood].'

Dr. Manson does not appear to have made out where they go or what becomes of the embryos after they have quitted the blood, nor how they re-enter it; but it is not perhaps unreasonable to suppose that they get into the lymphatics, within which, at any rate in some cases, some remain and cause the obstruction of the lymphatic current. Dr. Manson remarks that we must not conclude that a case is non-filarious from observations made during the afternoon. The search, he says, should be made after sunset.

(5) *Oxyuris vermicularis*.—The common thread-worm, though properly an inhabitant of the lower bowel only, may occasionally come under the cognisance of the surgeon when it has found its way into the female vagina, or wandered into loose mucous folds external to the anus, where as in a case mentioned by Cruveilhier, and cited by M. Davaine,¹ it may give rise to considerable annoyance. Another circumstance also connected with the presence of thread-worms is the sympathetic irritation sometimes said to be produced by them upon the sexual organs, leading, according to Lallemand,² to frequent seminal emissions and other evil consequences.

IV. ARACHNIDA.—The only forms belonging to the Arachnida that can be properly regarded as human parasites, although many others may occasionally attack the human subject, are,—

1. *Acarus* (*Demodex*) *folliculorum*.
2. *Sarcoptes* (*Acarus*) *scabiei*.

Both of these, however, are more properly to be considered under cutaneous diseases or eruptions, and will therefore be passed over in this place.

V. INSECTA.—The same, with one exception, may be said of the parasitic insects, of which we will content ourselves with giving a list only:—

- | | |
|-------------------------------|----------------------------|
| 1. <i>Pediculus capitis</i> . | 4. <i>Pulex irritans</i> . |
| 2. " <i>vestimenti</i> . | 5. " <i>penetrans</i> . |
| 3. <i>Phthirus pubis</i> . | |

Concerning ourselves here only with the last.

Pulex penetrans, the sand-flea (chigoe, chigger, or jigger), is considerably smaller than the common flea, and has a proboscis as long as the body. The male, and also the female until impregnated, lives solely in sand, and does not attack man; but the impregnated female is one of the worst pests in the West Indies, and in many parts of South America. Humboldt states that it only attacks Europeans, and not the aborigines; but there is no doubt it is as much attracted by the negro as by the white man. The impregnated female introduces itself beneath the nails or between the toes and other parts of the naked foot, and soon enlarges into a white globular vesicle about the size of a pea, by the rapid growth of the ova, or rather larvæ, which are formed and contained in a membranous bag beneath the abdomen. The presence of this rapidly growing intruder causes considerable irritation and annoyance, and if the distended ovary be incautiously ruptured, the escape of the numerous progeny into the surrounding tissues is often followed by suppuration and tedious ulceration. The treatment, which requires some skill and sharp eyesight, consists in dilating the orifice through which the insect has entered with a needle, and carefully extracting it whole.

¹ *Op. cit.* p. 211.

² *Des Pertes séminales involontaires*, t. iii.

VEGETABLE PARASITES.

A considerable number of vegetable parasitic growths have been enumerated as infesting man as well as many other animals, and affecting both the external surface of the body and some of the internal mucous passages which are exposed to the air. These growths belong, for the most part, to the hyphomycetous fungi, and, with perhaps one or two exceptions, amongst which the fungus peculiar to *favus* should, in our opinion, undoubtedly be included, they are in all probability merely different forms of the common mould (*Penicillium glaucum*), or of other minute fungi of a common kind. At any rate, as they all, or nearly all, are closely connected with certain cutaneous affections which have been treated of elsewhere, it will be needless here to say anything concerning them. It is far otherwise, however, with a particular form of fungus, which appears to constitute the essence of a very serious surgical disease in the East.

In the 'Transactions of the Medical and Physical Society of Bombay,' No. VI. for 1861, p. 104, will be found an elaborate paper by Dr. H. Vandyke Carter, concerning a 'New and Striking Form of Fungus-Disease principally affecting the Foot, and prevailing endemically in many parts of India.'

Though the true nature of this extraordinary affection is for the first time explained in this valuable paper, the affection itself appears to have long been noticed by Indian surgeons as one of a peculiar kind. It was distinguished in the medical reports under the name of 'ulcus grave,' 'morbus tuberculosus pedis,' 'Madura-foot,' 'peculiar tubercular disease,' &c. The disease appears to be of not unfrequent occurrence in the Bombay and Madras presidencies, and since its nature has been made known cases of it have been met with also in Bengal. It appears, therefore, to pervade most of the hotter parts of the Indian Peninsula. It attacks men far oftener than women, and is almost exclusively confined to the feet.

Dr. Carter distinguishes at least two varieties of the affection; and the account he gives of a case¹ will serve very well to afford an idea of the appearances produced by it. The subject was a Hindoo farmer, aged about 35 years, residing near Poonah, in the Deccan. When admitted into hospital on September 21, 1859, his right foot was much enlarged, particularly about the ankle; the general form of the swelling was oval, somewhat resembling that of extensive serofulous caries of the part; the skin was thrown into coarse corrugated wrinkles. On either side of the ankle-joint and on the dorsum of the foot, near the toes, and also in the sole, were numerous soft small swellings or tubercles as large as a pea or marble, having puckered apertures or fistulous openings; and at these points the skin appeared lighter in colour than elsewhere. The tubercles were in all stages, from a slight elevation of the surface to an acuminated point, and there a puckered fistulous orifice appeared. A probe introduced into one of these openings entered a long but not tortuous sinus, many of which led to bare bone. A discoloured glairy sero-purulent fluid exuded on pressure, frequently mixed with a few black gritty particles. The toes were distorted and displaced upwards, and the muscles of the calf were atrophied. The disease was of twelve years' standing, and the history given was this—When wading in a nullah, or water-course, a thorn stuck in the sole of the foot; bleeding followed, and an abscess formed the size of a walnut. The swelling began to spread, without much pain, from the sole of the foot and toes towards the ankle. Amputation was performed, and the patient made a complete recovery.

On section of the parts after removal, the disease was at once seen to be characterised by the presence of numerous black masses, studded throughout both hard and soft parts. There was no deposit in the cancelli of the bones, and no blending of the parts, as observed in cancer; and the black masses could be picked out quite clean from the cavity or space in which they were contained, and which was lined with a membrane. There was no appearance of caries, the osseous tissue having been removed apparently only by absorption. Nor was there any alteration or thickening of the soft parts, such as occurs in elephantiasis, &c.

In the second variety, although the external appearances are not unlike, a considerable difference exists in the absence of the black masses. The bones are affected nevertheless in a similar way, and a fungus is also to be found. In a case recorded² of this variety, the 'diseased parts consisted of collections of what looked like sloughing tissue; grey or blackish masses, almost glairy in consistence and accumulated in loculi, from which they could be readily drawn out, whether in the soft parts or in the bones, which were excavated to receive them. No black granules were seen, and only after a careful examination were white granules detected in the interior of the loculi.'

The discharge from the sinuses was examined, prior to the amputation, by the microscope: it presented, together with blood-corpuscles and granule-cells, numerous small bodies barely visible as white dots to the naked eye; but when magnified, appearing rounded and tuberculated, of a yellowish tint, and slightly varying in size. These were the fungi.

In some cases, where the disease is still more advanced, the destruction and obliteration of parts is still greater, till at last scarcely any remains of the original tissues, either hard or soft, are recognisable. The general characters of the affection are thus summed up by Dr. Carter:—

1. *External appearances.*—Globular, or flattened form of swelling, often very considerable; never extending above the foot. Skin first studded with blebs or soft tubercles marked with

¹ *Loc. cit.* p. 111.² *Loc. cit.* p. 115.

numerous sinuous apertures. A thin discharge, often scanty and watery, and generally containing small granules or particles, either barely visible or distinct, soft, and like poppy-seeds, or black in colour.

2. *Appearances on dissection*.—General confusion of parts, owing to absorption of the bones, and fibrous thickening of the soft parts. Often the presence of granules, separated or aggregated into mulberry-like masses of a yellow or brown colour, lodged in spherical cavities excavated in the bones or soft parts, or in tunnels or channels leading from the cavities to the openings on the surface, and also lined with a membrane.

Sometimes there is a deposit of a fleshy substance, containing numerous minute particles (white or red), and occupying the same localities as the above-mentioned granular deposit. Lastly, in the same cavities and tunnels may be found black granules, spheroidal tuberculated masses of the same colour, and radiated in structure.

Dr. Carter adduces many considerations to show that this curious parasitic fungus is introduced from without, and draws a close comparison between the mode of its invasion and reproduction with that of the guinea-worm, which is highly interesting, but too long for notice here.

Masses of the truffle-like fungoid tubera having been furnished to Mr. Berkeley, that eminent fungologist has procured from them the mycelium and fructification, and has thus determined the botanical characters and systematic position of the fungus, to which he has given the name of *Chionyphe Carteri*.¹

Amputation of the affected part appears to be always successful in putting a stop to the extension of the mischief.

Amongst other parasitic organisms usually, though perhaps doubtfully, referred to the vegetable side of the organic world, should also be here enumerated the numerous and most important class known under the general appellation of *Bacteria*, *Bacilli*, *Vibrio*, &c., of which our knowledge has been so materially advanced in late years.²

Though, speaking generally, these organisms are of more immediate interest to the physician than to the surgeon, yet their high importance in surgical practice, as in the treatment of wounds, and in operations, demands that they should not be here passed over without notice. Any extended account of their life-history would form an essential part of an article on 'Antiseptic Surgery,' in which it would find a more appropriate place.

G. BUSK.

¹ *Intellectual Observer*, vol. ii. p. 248.

² In a report to the Medical Society of Christiania in 1874 by Dr. Hansen, and of which a notice appeared in the *British and Foreign Medico-Chirurgical Review* for April, 1875, he briefly stated that he had frequently or indeed generally found when seeking for them in the tubercles of leprosy (*elephantiasis græcorum*) small rod-shaped bodies in the cells of the swelling. His subsequent investigations, of which an account was published in the *Quarterly Journal of Microscopic Science*, vol. xx., N. S. p. 92, 1880, have apparently served to confirm the view that these minute *bacilli* are the invariable concomitants of the disease, and apparently its immediate cause. The case is one of extreme interest, and from the kindness of Dr. Thin, who is at present engaged in its investigation, I have an opportunity of witnessing the existence of the *bacilli* in preparations taken from a subject in this country. It would seem that they are not confined to the morbid growth itself, but are extremely abundant in the subjacent apparently unaffected tissue.

VENOMOUS INSECTS AND REPTILES.

UNDER this head is included the consideration of wounds inflicted by animals into which some poisonous or irritating material is introduced. In this country and in many others the subject is one of little importance; but in some, more especially in the warmer regions of the globe, it demands the serious attention of the surgeon. But from the great general similarity, except as regards degree of severity, in the effects produced by wounds of this kind, and as their treatment is to be guided by obvious and simple principles, there is neither room nor need for any extended observations on the medical or surgical aspect of the question. But we have thought that some space might be usefully occupied in pointing out the different classes of animals amongst which venomous species are found, and in indicating those species more especially whose attacks are most to be dreaded.

A. INVERTEBRATA. *Poisoned wounds inflicted by insects and Arachnida.*—In this section might be enumerated a considerable number of species whose bites or stings are attended with a greater or less degree of irritation and inflammation; but from the trifling nature of the injuries inflicted by most of them, it is unnecessary here to notice any but those whose attacks are attended with what may be termed serious effects.

Considered in this regard, the most formidable of the venomous invertebrate animals belong to the classes Arachnida and Myriapoda. Under the former are included the scorpion, of whose venomous properties there is no doubt, and several spiders, whose evil reputation rests perhaps upon less certain grounds. The only myriapod that can positively be said to possess any venomous power is a species of scolopendra (*S. morsitans*).

(a) *The scorpion (S. europæus, S. occitanus, &c.)*—The scorpions (Scorpionidæ) are characterised by their elongated jointed caudiform abdomen, which is armed at its extremity with a hooked claw. This claw, which is perforated and connected at the base with poison-glands, constitutes the *sting*. In the larger species, inhabiting the hotter regions of the globe, the effects of the scorpion's sting in man appear to be very serious, if not in some cases actually fatal; and even in the smaller species found in the South of Europe its effects are very unpleasant, and not altogether unattended with danger to delicate or irritable individuals. The symptoms produced by it very much resemble those produced by the stings of bees and wasps in an aggravated degree: such as acute pain, a general nervous shock attended with numbness, vertigo, occasionally temporary loss of sight, vomiting, &c., whilst the local symptoms are swelling and other signs of acute inflammation, followed in many cases by suppuration, sloughing, and their consequences.

The remedy which appears to have obtained the greatest repute, and to be recommended by the most trustworthy evidence, is the application of ammonia externally, and its internal administration as a stimulant also; although it is probable that any other diffusible stimulus combined with opiates would be equally, if not more, efficacious. A variety of plants, belonging more especially to the Cruciferae, have also been supposed to possess useful properties in the treatment of the effects of the scorpion's sting.

(b) *Centipedes (Scolopendridæ)*.—Several species of *Scolopendra* enjoy the reputation of being highly venomous; and there is, perhaps, no doubt that the bite of some of the larger kinds, and especially of *S. morsitans*, a large species inhabiting the hotter regions of the globe, has occasionally been attended with very troublesome and painful consequences. The poison of these creatures is conveyed not by a caudal sting, as in the scorpions, but by somewhat similarly-formed curved fangs connected with the mandibles, which are perforated, and probably communicate with special poison-glands, although the existence of such organs does not appear as yet to have been satisfactorily made out. The bite of the centipede, though described as excessively painful, does not seem to be usually followed by the same severe symptoms as is the sting of the scorpion; and it is not improbable, therefore, that no poison is actually introduced.

(c) *Spiders (Araneida)*.—The bite of several species of spiders is said by various writers to be venomous; but the testimony, speaking generally, upon which this property is attributed to them does not appear to be very conclusive.

Spiders have from time immemorial enjoyed the evil reputation of being highly poisonous when swallowed, and very powerful medicinal properties have even been assigned to their webs. These notions, however—no doubt due to the disgust felt by most persons at the sight of such ugly creatures—are of course totally unfounded; nor, perhaps, with one or two more or less problematical exceptions, does there seem to be any better reason for believing that their bite inflicts more than a simple wound.

One or two species, however, deserve more particular notice.

The first of these, the tarantula or tarentula (*Lycosa tarentula*), a large spider belonging to the tribe of Citigrade, or running spiders, and which abounds in Southern Europe, and more especially in South Italy, has long acquired an extraordinary, but, as it would seem, wholly undeserved, infamous reputation. The concurrent testimony of all competent observers has conclusively shown that the extraordinary stories of the affections produced by the bite of the tarantula, and of the no less extraordinary methods of cure adopted, are the records either of wilful deception or of the strange pranks the imagination may play in the apparent production and removal of morbid symptoms. Direct experiments in various hands show that the bite of this spider is unattended with any ill effect beyond slight local irritation.

Another spider, belonging to an entirely different tribe, but which is also found in the South of Europe, is said to produce a similar train of symptoms to those attributed to the tarantula, and doubtless having the same origin.

A third species (*Aranea 13-guttata*) is also reputed to inflict a very dangerous and even fatal bite both upon men and domestic animals in the island of Elba; and in Morocco a spider, there called the *tendaraman*, has had equally formidable venomous powers attributed to it. It is said to be common in the cork forests; and that its bite is so poisonous that the persons bitten by it survive but a few hours. But we may surely be allowed to doubt all such stories; especially when we learn that the spider always makes towards the head in order to inflict its deadly wound.

(d) *Venomous insects*.—A great variety of insects appear to have the power of inflicting wounds attended with a greater or less amount of local irritation. But whether in the majority of these cases any poison is actually introduced into the punctures made by their lancet-like proboscis appears to be by no means certain. It is highly probable that the effect, as is often the case with leech-bites, is due to prolonged mechanical irritation only. It must be confessed, nevertheless, that in other cases the severe pain which attends the bites of very minute creatures can scarcely be accounted for, except on the supposition that they are accompanied with the introduction of some irritating, if not actually venomous material; as of formic acid, for instance, in the case of ants; or perhaps of an acrid salivary secretion in other insects.

In some cases, however, it would seem that certain insects are capable of affording a truly poisonous matter of a septic and diffusive nature, by which, independently even of any local irritation, the whole system may be fatally affected. The most remarkable case of this kind is that of the dipterous fly termed 'tsetse' (*Glossina morsitans*), of whose ravages, or supposed ravages, we have so graphic though unsatisfactory an account in Dr. Livingstone's travels. It is true that this fly is innocuous to man; but nevertheless, its alleged effects upon certain animals are so extraordinary, and it might almost be said so incredible, as fully to deserve some notice in this place. The tsetse is a harmless-looking insect, very little larger than a house-fly; but its bite is said to be certain death to domestic cattle, the sheep, horse, and dog, whilst it is innocuous not only to man, but to the goat, antelope, ass and pig, as well as to all wild animals whatever, and even, what is strangest of all, to the calf so long as it is sucking. The symptoms attributed to the bite of the tsetse do not arise immediately, but after an interval sometimes of several weeks. They appear to commence with a general disorder, attended with weakness and wasting, running at the nose and eyes, and glandular swellings under the jaw. The animals so affected invariably waste away and perish. The affection is said to be quite different from the 'leg-sickness,' and other murrains, which are so common in South Africa; and to present this striking difference from them, that it is not contagious. A herd of healthy cattle is not infected by animals labouring under the effects of the tsetse-bite. Nor is an animal ever affected in the same way unless it has been into a district of country infested by the fly. These districts are described as being very distinctly defined, although separated from a healthy one sometimes only by a narrow river, or even by an imperceptible boundary. Nothing appears to have been ascertained with respect to the infected tracts of country being inhabited by any peculiar plant or vegetation; but, on the other hand, travellers seem to have convinced themselves that the tsetse-fly is never found except in districts inhabited by the elephant and rhinoceros; and that in proportion as those animals are destroyed, do the ravages of the fly diminish. It is much to be desired, however, that the subject should be further investigated.

Dr. Livingstone also mentions another insect, whose bite produces vomiting and purging in the human subject; but as he enters into no particulars we can merely notice the circumstance as one, if truly reported, of a very remarkable kind.

But although the bites of insects are comparatively so innocuous, it is otherwise with their *stings*. Stinging insects belong chiefly, if not exclusively, to the order Hymenoptera, in which the sting, in the sterile females, represents the modified ovipositor. The instrument consists essentially of two exceedingly fine and sharp darts, enclosed in a tubular sheath, at the base of which is placed a special venom-gland or sac, whose contents are injected into the wound made by the usually serrated or barbed darts. The well-known consequences of the sting of the bee, wasp, and hornet are too familiar to require particular notice. Though painful and annoying, these wounds, except in cases of persons attacked by numerous swarms, can rarely be accounted serious, though the effects vary a good deal in different persons, and probably are more severe in warmer districts. When large communities of Hymenoptera, however, are disturbed, and the assailant is attacked by great numbers of the angry members, very severe consequences, and even death itself, have often followed; and in one instance at

least the sting of a single insect (*Mutilla coccinea*), a native of the warmer parts of North America, is said to produce loss of sense within five minutes after its infliction, and considerable apparent risk to life for several days afterwards.

Various remedies of a domestic nature are recommended to allay the smart and inflammation attending stings; amongst which vinegar, ammonia, flour, indigo in the form of the 'blue-ball' of washerwomen, oil, spirit, eau de Cologne, &c., may be enumerated. Of these, ammonia in the form of sal-volatile or eau de luce is perhaps as good as any.

B. VERTEBRATA. Wounds inflicted by venomous snakes.—Of a far more important character than those noticed in the preceding section are the poisoned wounds inflicted by animals belonging to the vertebrate sub-kingdom. Fortunately, as compared with the whole number of vertebrata, these are not very numerous, nor are they very powerful, except in the possession of their lethal weapons; and as they are for the most part slow of movement, and of a sluggish and retiring nature, they are not to man, at least in one sense, of any very great importance. The serious and often fatal nature of their attacks, however, renders the subject of the wounds inflicted by them one of considerable interest and moment, especially in countries where the more powerful species are met with.

All the truly venomous vertebrata belong to the order of Ophidian reptiles; to some few points with respect to the natural history and organisation of which, bearing upon the main subject of this section, we shall therefore now proceed to refer as briefly as possible.

Characteristics and classification of venomous reptiles.—Many systematists have begun their classification of the Ophidia by dividing them into the *innocua*, the *suspecta*, and the *venenosa*. But the exigencies of more recent zoological science demand a more exact classification than is afforded by such an artificial arrangement. Not to enter at any length into the principles upon which various schemes for their classification have been based, it will, for our present purpose—that of diagnosing venomous from non-venomous snakes—be sufficient to remark that the Ophidia are very naturally subdivided into two large groups or sub-orders, clearly distinguished from each other by various particulars in their organisation. In one of these sub-orders all the species of which it is composed are more or less venomous; whilst in the others the majority are innocuous in that respect, though some are truly formidable in other respects.

The former group of true venomous snakes have been termed the *Viperina*, or viperine snakes, of which the rattlesnake and viper are familiar examples; whilst the second have been denominated the *Colubrina*, of which the common harmless ringed snake of this country is a specimen.

To the latter belong all non-poisonous snakes and some poisonous, as the cobras of India and Africa, and the whole family Hydrophidæ, or sea-snakes of the tropical seas. To the viperine group belong the true Viperidæ and the Crotalidæ, or rattlesnakes.

The *fang*, as has been said, is traversed by a narrow canal, continuous above with a sort of pouch or *sacculus* surrounding the base of the tooth, into which opens the long curved duct of the *poison-gland*. This organ, which with various modifications may be described as composed of tubular follicles communicating with a common canal, and consequently as quite distinct in structure from an ordinary salivary gland, has a thick aponeurotic wall surrounded by muscular fibres, in most cases apparently connected with the temporal muscle, and which are supposed to act as compressors of the gland and ejectors of its contents. It is usually placed below and a little behind the orbit; but in one remarkable instance—*Causus rhombeatus*—the poison-gland, which is of enormous size, is situated on the back, extending from the nape through nearly one-sixth of the entire length of the body, lying immediately beneath the integument and superficial to the ribs and their muscles.

The *colubrine snakes*, among which are included the Hydrophidæ, or sea-snakes, differ in several important particulars from the Viperina. In external form they are usually slenderer and more elongated, especially in the caudal region. The head is smaller or narrower in proportion, and in nearly every case continuous, as it were, with the body, and in all the more important members of the sub-order covered on the summit with large scutes or plates, usually nine in number; the scales, except in the sea-snakes, in which they are tuberculate, are smooth and non-carinate; the eyes are larger in proportion than in the Viperina, and, except in one or two genera, have an orbicular pupil. To these general external characters may be added that their movements are more lively and active, and colours in most cases more brilliant and pleasing. Important differences also exist between the two groups in the structure and connections of the cranial and facial bones, and especially in the dentition, in which their great distinction exists. Among these differences we may briefly notice the greater strength and compactness of articulation of the jaws and other bones connected with them, by which the oral cavity and gullet are rendered far less dilatable than they are in the Viperina; and the greater length and size of the maxillary bones, which are furnished with numerous solid conical fixed teeth.

This great sub-order includes by far the largest number of snakes, varying in size from that of an earth-worm to the gigantic dimensions of the boa-constrictor and great pythons. Fortunately, few of these genera of snakes are venomous; but among those which are so, we find some of the most formidable of all. With the exception of the sea-snakes, or Hydrophidæ, all of which are reputed to be highly venomous, and are at once distinguishable by their exclusively marine habitat, vertically flattened form, and fish-like habits, it is not easy to lay

down in words any very accurate means of distinguishing the venomous from the non-venomous Colubrina. The former usually have the muzzle larger and blunter than the rest; the trunk more elongated, and the tail shorter, stunted, and conical; the eyes smaller, and in some cases with a vertical opening, although the pupil is always round; the nostrils wide and lateral, &c. But the more important species of this group, or those belonging to the genus *Naja*, are characterised by the faculty they nearly all possess of expanding the sides of the neck when in an excited state, whence they are sometimes distinguished by the appellation of hooded snakes, or Cobras de capello. The essential character, however, by which the venomous are distinguished from the non-venomous Colubrina, is the development in the upper jaw of the former of one or more of the anterior maxillary teeth into poison-fangs. As we have said before, these teeth are always fixed or non-reclinable; and they differ also from the true poison-fangs of the Viperina in not being perforated down the centre by a canal, but are adapted to the purpose of conveying poison into the wound by a groove on their anterior or convex side, which is in connection—much in the same way as the canal in the viperine fang—with a special poison-sac or gland: the chief difference being that the duct is short and straight, instead of long and curved, as in the latter case.¹

Nature of the 'venom,' and its effects.—We shall proceed to say a few words respecting the nature of the poisonous secretion itself, and to describe the effects which follow its introduction.

The venom of serpents is described, when fresh, as a transparent yellowish or greenish subviscous neutral fluid very much resembling saliva. In other sensible properties it is said to be insipid and almost inodorous, and, in fact, to exhibit no obvious character denoting its virulent properties. It is heavier than water, and not very readily miscible with it; the mixture when shaken becoming turbid. According to Prince Lucien Bonaparte, it contains, besides albuminous or mucous and a small amount of fatty matter and the usual salts, a peculiar principle to which he has given the name of 'echidnine' or 'viperine,' but which appears, in most of its characters, strongly to resemble ptyaline. It is said, however, to possess active poisonous properties, which are retained even after it has been dried for a considerable time, if not exposed to the air. But, however simple in appearance and composition this fluid may be, it undoubtedly possesses the most energetic and remarkable physiological properties.

In the first place, it appears to be quite certain that the poison produces no effect, or scarcely any, beyond a temporary irritation of the passages, when introduced into the stomach; the only exception to this being some instances in which it would seem that pigeons were stupefied for a short time after being made to swallow it; at any rate its introduction in this way never seems to be followed by any very serious consequence. Nor does it produce any deleterious effect beyond, in some cases, a little local irritation, when applied to the surface of the skin, even when it has been slightly abraded. It would also appear, from Fontana's experiments, that it is innocuous when applied to an exposed surface of muscular tissue, to cartilage, the pericranium, periosteum, the dura mater, to the medullary cavity of bones, the cornea, tongue, lips, palate, &c. Applied to exposed nerves, it is equally inert; nor does it apparently affect the irritability of detached muscle. In fact, it may be said that the general result of experiment and observation tends to show that in order to produce its specific effect, the poison must be introduced directly into the subcutaneous cellular tissue, though even here curious anomalies have been observed; amongst which is the circumstance that direct inoculation with the aid of a cutting instrument is less likely to succeed than when the poison is introduced through the fang itself. This, of course, may be owing to the greater outflow of blood in one case than in the other.

When properly introduced, however, its effects are very rapidly manifested; in fact, in some cases so rapidly as more to resemble those of prussic acid than anything else; usually, however, a brief interval elapses before the effects are shown. These may be divided into general and local. The first symptom, in nearly all cases, appears to be a general shock to the nervous system, attended with faintness, tremor, and great depression—sometimes with

¹ Besides the undoubtedly venomous snakes above referred to, there is a large class of Ophidians, with grooved or channelled teeth, with respect to whose venomous or non-venomous properties the opinions of naturalists have been and are still much divided. In these snakes, which have by some been termed '*suspecta*,' the channelled teeth are situated, not in the front of the upper jaw, as in the truly venomous serpents, but behind. It has been conclusively shown in many cases, and can hardly be doubted in any, that the channelled teeth are in connection, by means of a special duct, with a considerable-sized gland, with regard to whose nature it is that opinions have been chiefly divided. Whilst some eminent observers, as Johannes Müller, Milne-Edwards, and Duvernoy, ascribe to it the structure and functions of a true poison-gland, others, as Schlegel, Andrew Smith, Owen, and more recently A. B. Meyer, describe it as having the structure and presumably the functions of a simple salivary gland. The accounts of travellers, also, respecting the effects of the bite of this class of snakes, are fully confirmatory of its non-poisonous nature in the majority of cases. But quite recently (*Monatsbericht der k.k. Ak. d. Wissenschaft*, Berlin, März 1869), it has been shown by the last-named author, that in at least two species of the most innocent-looking snakes (*Callophis intestinalis*, and *Callophis bivirgatus*), the posterior channelled teeth are connected with enormous true poison-glands, much larger, in fact, than those of *Causus rhombeatus*, and which, strange to say, are lodged, not superficially, as in that species, but within the cavity of the ribs, and in front of the heart, occupying nearly one-quarter of the length of the body. Although extended investigations have as yet failed to show the occurrence of similar organs in any other species of the '*suspecta*' than those above named, it is not improbable that such may exist, and consequently in the case of any unknown snake it will be prudent to adhere to the old maxim of *fronti nulla fides*.

stupor, loss of sight, vomiting, trismus, and general insensibility; at the same time great and sometimes intense local pain is set up. The limb, if the wound is in one of the extremities, rapidly swells; at first pale, the surface of the swelling soon becomes red and afterwards livid, and covered with phlyctenulæ filled with sanious fluid. In severe cases the swelling continues to spread through the whole limb, till it reaches the trunk or even the entire body, whose surface assumes a jaundiced hue. The symptoms, in fact, very closely resemble those of ordinary phlegmonous erysipelas, or diffuse inflammation of the subcutaneous cellular tissue. The constitutional symptoms, independently of the first shock, are what might be expected to accompany such a local affection, and in intensity are in proportion to its violence.

The gravity of the effects of the bite of a venomous snake appears to be in direct ratio to the comparative sizes of the snake and its victim, and also to the quantity of poisonous secretion present at the time in the saccular gland. It is also greatly governed by the situation of the wound; one on an extremity, for instance, being far less dangerous than on the face or trunk. It has been remarked also that two or more wounds at distant points are more rapidly effective than when they are inflicted in one spot, owing doubtless to the more rapid diffusion which takes place in the former case.

From a general survey of what is known, it would appear that the poison, in whatever principle it may reside, is one which acts primarily on the nervous system, and also as a septic poison on the tissues with which it is brought in contact; and that in order to produce its effects, it must be directly introduced into the circulation.

In the present state of our knowledge it would be a waste of time to speculate upon the real nature of such poisonous, and, as it would seem, such apparently acrid, properties in a seemingly bland and harmless secretion. Its local effects might be regarded as due to its acting as a septic ferment, analogous to that by which many kinds of blood-poisoning are brought about; but if so, the 'venom' would seem to differ from all such ferments with which we are acquainted in the circumstance that its effects vary in intensity directly with its quantity. The minutest possible portion of the variolous poison, or of the septic agent by which scarlatina and other analogous affections are produced, is as efficacious as a larger quantity; and the same may be said also of the septic poison introduced in a dissection-wound, of which the quantity introduced necessary to produce the same amount of local mischief is infinitely smaller than would be required in the case of the serpent's venom. That the effects of a septic ferment should be proportionate, except in a very remote and almost infinitesimal degree, with its quantity, is apparently contrary to all analogy; and at present, therefore, we are hardly justified in looking upon the venom of snakes simply as such a substance, notwithstanding that it possesses some of the properties incidental to it.

It might perhaps be suggested that the 'venom' may reside in a principle analogous to, though quite different from, *ptyaline*, and, like that principle, capable of exerting a rapid catalytic action upon some of the constituents of the blood, under the innocent guise of an inert substance.

With respect to the treatment of 'envenomed' wounds, and further observations on their nature, all that is necessary will be found under the head 'Poisoned Wounds,' vol. i. p. 321.

G. BUSK.

SURGICAL DIAGNOSIS AND REGIONAL SURGERY.

SURGICAL DIAGNOSIS.

DIAGNOSIS is the term used by physicians and surgeons to express the scientific opinion or theory which they form of each case presented to them in practice. The art of diagnosis may justly be said to be the main object of the study of medicine; as being the end to which all its theoretical parts converge, and the source from which all its practical rules proceed. The substances comprised in the *materia medica* are indeed innumerable, the varieties of surgical appliances and operations are infinite; and a competent knowledge of them is of course one of the fundamental requisites for a good practitioner. Still it is none the less true that the successful application of every one of those means depends upon a correct diagnosis of the morbid action which it is intended to subdue. Hence, a complete treatise on diagnosis is almost equivalent to a complete treatise on medicine; and to endeavour to write fully on surgical diagnosis in this place would be little less than to re-write the whole of the preceding work. But the student of the foregoing pages will, it is hoped, find there all that is necessary to guide him in the emergencies of practice, as far as a book can assist him. The object of what follows is rather to point out the general principles on which surgical diagnosis is founded, and to endeavour to impress on the student the great importance of a full, and above all a methodical, plan of taking notes of cases. To no part of a surgeon's duties is less attention given than to 'taking cases;' and yet it is of great importance towards acquiring the power of correct diagnosis, a power which is the chief requisite for successful practice. Without in any respect undervaluing the triumphs of operative surgery—in fact, while confessing that the successful performance of a great operation is the highest pleasure which the pursuit of surgery affords—we may yet admit that many men of inferior powers have been bold, handy, and successful operators. But the attainment of great skill in diagnosis requires a combination of natural and acquired gifts which are not within every one's reach; an amplitude of information not to be afforded by any single experience, and which therefore can only be got by extensive study of surgical literature; a familiarity with morbid symptoms and appearances, and a readiness in combining and in interpreting them, which book-learning is quite unable to give, and which can be acquired only by long and careful study of disease at the bedside; and finally, and above all, a logical power of mind which neither study nor experience can confer, but which must be born with its possessor.

In the few pages which are here at my disposal I can only hope to give a short exposition of the most elementary and universal principles of surgical diagnosis, with a few familiar illustrations of each topic, chiefly selected from the foregoing essays. I shall then proceed to illustrate the most important element of surgical diagnosis—viz. the anatomical examination of the diseased part—by some account of the more familiar surgical affections as they appear in the various main regions of the body.

All diagnosis, both medical and surgical, rests on three chief elements—viz. 1st, the history of the patient and of the disease previous to the time of examination; 2nd, the symptoms of the disease at that time—i.e. the functional disturbances which it has produced; 3rd, the physical examination of the diseased part. These elements are common both to medicine and surgery; but while medical diagnosis relies mainly on the two former, and chiefly the second (except in diseases where auscultation plays the chief part), surgical diagnosis, on the contrary, is mainly concerned with the third, and hence its greater ease and greater certainty, since it deals more with matters cognisable by the senses. This, too, explains in some measure the great part which anatomy plays in scientific surgical education.

In order, therefore, to cultivate the art of diagnosis with success, the surgeon must be accustomed to investigate the previous history of the patient and of his disease both fully and accurately; he must then collect together the symptoms, and compare them with those of the various known diseases to which they point; he must be thoroughly conversant with every kind of physical examination, and especially that afforded by the sense of touch; nor, after all, will he be a master of diagnosis unless he has sufficient reasoning powers to see all these particulars in their proper relative proportion, and sufficient caution and deliberation to weigh them sedulously against each other. We see mistakes in diagnosis committed daily—there are few of us who have not to look back with mortification on many of our own; but most men's experience will bear out the statement that the great majority of them have been errors of *haste*, due in great measure to a pernicious habit, which the practice of our public institutions tends to create. There a great number of patients are to be attended to in so short a space of time that it is physically impossible to go through the successive steps mentioned above, of inquiring into the history, the symptoms, and the appearances of each

one as he presents himself: and the mind is too fatigued by the constant succession of varying phenomena to be able to follow out the reasoning process which is essential at the end of those successive steps. Hence we acquire the habit of leaping to a conclusion in the diagnosis of our own cases, and of acquiescing in the opinions of our colleagues on theirs, without submitting to the labour of examining them methodically for ourselves. Such a habit is, I am persuaded, one of the worst results of our hospital system, and particularly of the out-patient department of it, through which all the officers of hospitals now pass at the beginning of their career. A man who is compelled to see a hundred patients in a couple of hours (and this is hardly an exaggeration of the pace at which the machine is driven) acquires the habit of judging of the case from the first glance, and judges usually with correctness. No doubt much rapidity and decision is obtained by this practice, and there are cases in surgery where these are the qualities chiefly required; but there are many others in which errors can only be avoided by great patience, and habits of this kind produce a character of mind to which patience is a stranger. Hence it is very desirable for students and young practitioners to practise the investigation of cases, whenever it is possible, upon a methodical plan, and to commit their notes of the cases to writing. This is of course unnecessary in many of the simpler surgical cases, but is almost indispensable in some of the obscurer ones, and is a useful corrective of the hasty practice which I have thought it my duty to reprehend. It would, however, be a grievous mistake to suppose that haste is the only danger to diagnosis; and accordingly, in dwelling on the main considerations relative to each of the three elements of surgical diagnosis, the main sources of error connected with them will also be touched upon.

I. *History.*

The first main source of diagnosis, viz. the history, comprises all the facts relating to the patient's ordinary circumstances, such as age, sex, and occupation, which are likely to throw light on the disease to be diagnosed; the circumstances under which the disease first showed itself, its alleged cause, the particulars of the first departure from health, the date at which the patient first sought medical advice, the nature and effect of the treatment adopted, and the progress of the malady up to the time of examination. These particulars are furnished by the patient himself; but they can in many cases be checked or corroborated by the records which the disease has left on the body, in the shape of the marks of old abscesses, the distortions produced by inflammation of muscles, the atrophy of disuse, the results of old disease of joints, &c.

Let us consider these particulars somewhat more in detail.

Age.—The patient's age is one of the most essential particulars in forming a diagnosis of the affection. That this is so at the extremes of life every one is aware. Thus, for instance, in the affections of the hip-joint. If it be an injury of the hip that is under examination, we know that intra-capsular fracture rarely occurs except at an advanced period of life, and never in youth; that dislocation is very rare in childhood; and that fracture of the cervix femoris within the capsule is a comparatively common effect of slight violence in old people of relaxed fibre. If it be a disease of the hip which is presented to us, we at once consider that in childhood the so-called strumous disease tending to, or depending on, chronic caries of the bones is exceedingly common, while acute abscess is rare; that in middle life the inflammatory affections which are excited by injury become more common; while at a more advanced period the main affection of the hip is that disease which was erroneously supposed to be peculiar to old age—chronic arthritis—the ‘*malum coxæ senile*’ of our older authors.

Amongst the numerous instances of the importance of paying attention to the age of the patient in forming the diagnosis, we may refer to the following examples taken from the previous pages of this work. In inflammatory affection of the cheek occurring in childhood, the presence or the imminence of that formidable affection called *carunculus oris* would be suspected, since this disease rarely occurs after ten or before one year of age (GANGRENE); while in later life rodent ulcer, lupus, and epithelioma are the prevailing affections. In the examination of these latter forms of destructive ulceration, it must be an important element in the diagnosis that rodent ulcers generally occur in the later half of life, and lupus in the earlier (ULCERS).

In affections suspected to be hysterical the period of life is of course of the utmost importance in diagnosis, since, though such affections occur to women at advanced periods of life, they are far more common in youth (HYSTERIA).

In injuries, if a distinction is to be drawn between dislocation and separation of the epiphysis, the period at which the latter point of bone is developed, and is joined to the shaft, must be steadily borne in mind (FRACTURES); and in disease of the bones in childhood the same particular is of very great importance (DISEASES OF THE BONES).

These are a few of the many examples which might be cited of the importance of paying attention to the age of the patient in forming the diagnosis. But errors may easily be committed if more stress be laid on this particular than it deserves. Thus Sir A. Cooper first taught the now admitted fact that intra-capsular fracture of the femur is an injury peculiar to advanced age; and he very justly dwelt on this fact, and on the indisposition of the fracture to bony union, and consequently the impropriety of treatment directed to promote union by enforced rest in bed and confinement in splints. But in proceeding so far as to teach that nearly all fractures of the neck of the femur in old people are of this class, and therefore insusceptible of union, there is no doubt that he exaggerated the influence of age; since it is now demonstrated that most fractures of the neck of the bone, even at an advanced period of life, are partly extra-capsular (INJURIES OF THE LOWER EXTREMITIES).

Sex.—The importance of sex in the diagnosis of surgical affections is not limited to those of the genital organs and mamma. Other organs, such as the thyroid body, are notably modified in their affections by the influence of sex (DISEASES OF THE THYROID BODY); but besides this, the course and the character of all manner of diseases is different in males and females; and in the latter the strange sensibilities of the uterus lead to a train of symptoms must vaguely indicated by the term 'hysterical;' a term which is the only one we can use, though it frequently conveys a very false impression of fiction or exaggeration in cases where the symptoms are as real as those which depend on organic disease, though they are not dangerous to life. Unless such sexual peculiarities were kept constantly in view, the daily recurring, and quite innocent, painful affections of the limbs, the chest, the head, &c., would be constant sources of needless anxiety.

Errors in the diagnosis, however, proceeding from too readily attributing the diseases of females to hysterical causes, are so very common that the surgeon must be constantly on his guard against them. This is so ordinary a matter of experience that it is needless to cite many instances. The mistake occurs chiefly in the early stages of deep-seated diseases of the bones; as in the case of a young woman of hysterical temperament, admitted into St. George's Hospital for deep-seated pain about the pelvis. The disease, which was long treated as hysterical, then revealed its true nature by the formation of abscess; and death from caries of the sacro-iliac articulation ultimately ensued.

Occupation.—The patient's occupation is sometimes, although not very often, a matter of primary importance. Thus, in disease of the jaw, the fact of the patient being a worker in phosphorus would go a great way towards the establishment of the diagnosis. In diseases of the bursæ again, the patient being a tailor, a miner, a housemaid, would render the diagnosis more secure in case of a tumour situated over the fibula, the olecranon, the patella. Still more frequently the occupations connected with beer or spirit-drinking (potmen, butlers, draymen, &c.), and those very laborious trades in which the habitual drinking of great quantities of beer is regarded as almost a matter of course (navigators, coal-whippers, &c.), furnish a very valuable indication for the diagnosis and prompt treatment of the early symptoms of delirium tremens, so apt to follow injuries in such persons (DELIRIUM TREMENS). In some rarer cases the patient has been exposed to the usual influences of particular trades, though his occupation is different; as in Earle's case of the gardener who contracted soot-cancer on his arm from his habit of carrying a bag of soot to use in his garden.

Social condition.—The married or single condition should be noted both in men and women; and in the latter the number of pregnancies and of children, together with the causes, if known, of abortion. In the case of single persons it is often useful to know whether they are in the habit of illicit intercourse, and if so, whether such intercourse is promiscuous or not; and in all cases it is very desirable to be informed of any attacks of venereal disease, and its sequelæ.

Habits.—This brings us to two still more important matters in the patient's history—viz. his habits and his previous diseases. The previous habits of the patient very often account in a great measure for the symptoms which he presents, being the indirect, even if they are not the direct, exciting cause of his disease. It is hardly necessary to do more than allude to the importance which known habits of prostitution would have on the diagnosis of disease (such as a skin-eruption) suspected to be syphilitic; of drunkenness on that of restlessness, nervousness, and tendency to delusion; of masturbation on that of peculiar nervous symptoms.¹ But besides these extreme and familiar instances, there are many others in which a candid confession on the part of the patient might assist the surgeon's diagnosis most materially.

Closely connected also with the patient's habits of life is the character of his mind and his habit of body, both of which particulars often form important elements in the diagnosis, and materially assist the surgeon in determining on the reality of pain, the exaggeration of accounts of previous disease, &c.

Previous diseases.—The previous diseases must be carefully noted, since they often tend to throw light on the constitutional predisposition, and in the practice of surgery are perhaps of equal importance in accounting for local weakness and predisposition to disease. For an illustration of this we may refer to the diagnosis of cutaneous eruptions, or of affections of the bones, in which the history of a previous syphilitic affection, or of a strumous disease in childhood, will often be a main point in the diagnosis. This head will include of course the constitutional peculiarities which the patient may manifest.

But in these three preceding particulars, perhaps more than all others, great care must be taken not to exalt what is, after all, a mere presumption into an absolute indication. Very many cases are wrongly diagnosed and treated in consequence of forgetting the obvious truth that every disease occurring in an hysterical woman is not hysterical, nor every affection in a syphilitic patient syphilitic. Strumous children are not insusceptible of acute inflammatory affections, and these are often signally benefited by active treatment. Even in a cancerous patient we may meet with an innocent tumour, as is proved by the frequent occurrence in such persons of fibrous tumours of the uterus.

Hereditary tendencies.—Closely allied to the previous diseases which the patient has himself suffered from is the tendency to disease which he has inherited from his parents. In some cases this branch of the investigation is easy. Many families labour under hereditary tendencies to phthisis, cancer, or insanity, which are notorious, and are known to their friends as well as to themselves; but in many cases, and in diseases which are not so open to observation, it is otherwise. The most striking instance is congenital syphilis, in which not only is it extremely

¹ See a case by Mr. Hilton, in his lectures on Rest and Pain, p. 268.

difficult to obtain evidence from the person who is really in fault, but also the contagion may even proceed from an innocent person; as, for instance, a perfectly chaste woman who has borne children to a syphilitic husband, and thus has contracted the constitutional disease, may bear syphilitic children to a second (sound) husband; or, to take a less extreme case, a healthy wet nurse may be infected by her nursing and carry the disease into her own family, though both she and her husband may have been perfectly free from any known exposure to syphilis.

Of the great importance in diagnosis of the knowledge of the patient's constitutional tendencies, one of the most striking examples may be drawn from the essay on *ULCERS*, vol. i., throughout the whole of which this point is strongly dwelt on.

When all these preliminary subjects (which constitute the history of the patient) have been investigated, and duly noted, the examiner arrives at the history of the disease properly so called. This embraces the following main particulars: the alleged cause, the duration and onset of the disease, its course up to the time of examination, the nature and effect of the treatment which has been adopted, and some other miscellaneous circumstances.

The alleged cause.—The knowledge of the cause of a disease is of primary importance for its diagnosis. Often, indeed, it is in itself sufficient to establish the diagnosis, as in the instance above cited of the phosphorus-disease, where the cause is the patient's occupation combined with caries of the teeth. But it is often one of the most difficult circumstances in the whole investigation to decide accurately. There is an almost invincible tendency to ascribe the disease to some accidental injury which the patient may have suffered, especially if that injury have acted only, or mainly, on the part affected; and it is often impossible to say whether this causal connection is real or imaginary. Thus, to take a familiar instance, morbus coxarius in children is almost universally attributed by the mothers of the children to a blow, fall, or sprain, and by their medical attendants to the strumous diathesis, without which it is said that the local violence would have been harmless. Which party is more in the right? It is really very difficult to say; yet the point is very important to the diagnosis. If the disease be due to local violence in a child otherwise healthy, its character may be diagnosed as inflammatory, and local treatment may be expected to cure it; and so in the last resort, provided that so severe a measure be necessary, the excision of the whole of the diseased parts may often be expected to succeed; while if the affection be diagnosed as a constitutional one, the surgeon could hope little from local measures. I have selected this instance in order to afford myself an opportunity to put on record my conviction that the diseased joints of children are too often set down hastily as 'strumous,' when in reality the affection is in no manner connected with the strumous constitutional taint.¹ It is very well known how frequently disease comes on, even after the lapse of a considerable time, in parts which have been the seat of injury (vol. i. p. 295); but it is extremely difficult to decide whether this is due to a real connection, or is a mere coincidence.² But the difficulty of deciding as to the action of an injury is not unfrequently complicated by the doubt whether the injury has really occurred or no. For instance, how very often young female children are said by their parents to have contracted gonorrhœa from illegal intercourse, and how seldom is anything of the sort proved. If every such story was credited by those who see much of infantile leucorrhœa, they would get into constant trouble and disgrace (*SURGICAL DISEASES OF CHILDHOOD*). Besides such sources of deception, which rest upon honest mistakes (for the parents usually believe the disease to be so caused), the occasions for wilful deception are numerous. Many surgical diseases and injuries are caused by illegal or disgraceful acts, which the patient will not disclose, whatever may be the hazard of concealing from the surgeon the cause of his ailment (see the article on *APNŒA*). Instances of such purposed concealment come too often under the notice of every surgeon of experience, not to make them very cautious in receiving their patient's statements as to the alleged causes of disease; and therefore it is hardly necessary to quote instances of errors proceeding from a too ready acceptance of this part of the history. Perhaps one of the most fertile sources of these errors is the diagnosis, in affections of the larynx in children, as to the presence or absence of a foreign body (*INJURIES OF THE NECK*).

Still, the cause of the affection plays a great part in surgical diagnosis; in fact, it sometimes forms the basis of our classification of disease. An instance of this is afforded by delirium tremens. There are other conditions of delirium which it is otherwise difficult to distinguish from the 'delirium à potu,' but which occur in persons known to be temperate. Nevertheless it is justly held advisable to classify these apart (that is to say, to diagnose them as independent diseases), and to restrict the term delirium tremens to the delirium of drunkards. The nature of many diseases was unknown till their exciting cause was discovered—a striking instance of which is afforded by glanders; in hydrophobia, also, the knowledge of the cause would materially facilitate the diagnosis of the early stage of the disease.

Inflammatory and other affections are often found to depend upon causes very far removed at first sight from their visible effects, but connected with them by nervous sympathies, which a knowledge of the anatomy and physiology of the nervous system can alone explain. In such cases the diagnosis is the more important, since on it depends the cure of the effect

¹ Mr. Bryant would repudiate the term 'strumous disease' of a joint altogether (*Surg. Dis. of Children*, p. 123). This may be going a little too far, but the term has no doubt been much abused.

² It is well known that Sir B. Brodie's death was caused by malignant disease of the shoulder, and that the same shoulder had been the seat of dislocation some years before; but considering how often shoulders are dislocated, and how rarely any such disease follows, it is very difficult to believe that we have more in instance than a casual coincidence.

by the removal of the cause. This subject is illustrated by what is said at vol. i. p. 20, as to local inflammation excited by reflex or direct impressions on the nerves of the part inflamed, and by the many instances which are on record of the effects of deprivation of nervous power in exposing the part to gangrene.

Duration.—The duration of the disease is another point of the greatest importance in diagnosis, particularly with respect to the malignancy or innocence of tumours, to the inflammatory or chronic nature of diseases, and to a thousand such questions of everyday practice. In the diagnosis of the various forms of tumour in the groin and scrotum, the duration of the complaint up to the time when the tumour attained considerable dimensions is a point of extreme importance. The sudden formation of hernia, the gradual descent of psoas abscess, the slow growth of hydrocele, the rapid formation but slow increase of hæmatocele, the steady and rapid growth of malignant tumour of the testis, the slow increase and frequently the complete suspension in growth of varicocele—are among the points connected with this part of the subject which have been dwelt on in the preceding pages.

Yet here again errors may easily be made. Thus some innocent tumours grow more rapidly than some cancers do; and in all tumours we must remember that the growth may have attained a large size before it has been noticed. Sometimes the growth of cancer is suspended during even a very considerable time. Again, in the course of a chronic affection, acute inflammation may occur; and the duration of the disease may be greatly influenced by the patient's time of life.

Course of disease.—The course of the disease, from its outset up to the first visit of the patient, is of great importance, when it can be clearly traced; and so to a still greater degree is its course after the patient has come under treatment. There are not a few diseases of which no skill can enable the surgeon to give a confident diagnosis without a knowledge of their course. Examples of this fact might be drawn from every part of surgery; perhaps one of the best is the mistake which long prevailed with respect to cases of partial displacement of the head of the humerus with adhesion of the remains of the long head of the biceps to the bicipital groove. These cases are now known to be due almost, if not quite, always to chronic rheumatic arthritis, and not to rupture of the long tendon of the biceps from injury; the diagnosis having been established mainly by the course of the disease.

Effects of treatment.—When the nature and effect of previous treatment can be accurately ascertained, a great auxiliary to diagnosis is often acquired; in fact, in many cases the diagnosis can hardly be established without some such auxiliary. This is particularly the case in tumours of the testis, in which it is often impossible to tell whether the disease is malignant or simple chronic orchitis until the effect of a mercurial course has been noted (*DISEASES OF THE MALE ORGANS*). So in tumours connected with bone. It is often impossible to say whether the swelling be a strumous, syphilitic, or rheumatic node, or a new growth, until the effect of appropriate local and constitutional treatment has been patiently watched. But here especial care must be taken to guard against errors which are very liable to occur if the effect of treatment be judged of from the statements of the patient; so that little importance can be attached to this particular in forming the diagnosis, unless the treatment has been watched by the surgeon himself, or has been noted by another medical observer. Even then the temporary fluctuations occurring in all diseases are a fruitful source of error; as in the instance cited above of a tumour of the testis, in which the diagnosis between cancer and chronic inflammation is to depend on the effects of a mercurial course. In malignant disease, temporary improvement of the patient's condition, and even some apparent diminution of the tumour, often follow on the rest in bed and other measures which are then for the first time adopted; and thus the surgeon is liable to be deceived into the belief that his treatment is acting upon an inflammatory disorder.

II. *Symptoms.*

The second of our general heads is that which comprises the symptoms presented by the patient at the time of examination. These symptoms are either those which the patient describes or those which he exhibits. Here the second of our general heads touches closely on the third: for the examination of the patient's body discloses changes from the healthy condition which are in reality nothing but symptoms. In this place, however, it is intended to describe not the local lesions, but the general alterations from the natural state—the general physiognomy, as it were, of the disease. It is in the application of these general symptoms to the diagnosis of disease that the surgeon has most need of an intimate acquaintance with physiology, since he has to connect all the functional disturbances which he discovers with the appropriate lesions of the organs presiding over those functions, and those again with their possible causes. It is difficult to arrange these symptoms in regular order, as we have done the particulars embraced under the title of 'History.' Unlike what occurs in medicine, almost every surgical disease has its local seat, and the few diseases which affect the whole body, as struma, constitutional syphilis, multiple or constitutional cancer, and erysipelas, are generally obvious. Thus surgical diagnosis, as far as it deals with the symptoms of disease, is chiefly concerned in obtaining a minute knowledge of the signs of each particular local ailment, and in separating them from each other. When the surgeon has thus become accustomed to connect each disease with its own group of symptoms, he has to compare each group in his own mind with the account which the patient has given of his sufferings from the disease under examination. Here the difficulty is twofold. In the first place, as regards the groups of symptoms which we have been taught to associate with the name

of each disease. These groups have been laid down in our books, as is done in the previous part of this work, with all the conscientious exactness which the subject demands. But we must remember that the names of diseases frequently do not represent natural objects created different from each other; but are merely designations which have been affixed to sets of symptoms grouped together by nosologists. Now the infinite variety of nature easily eludes the bounds of our formal classification; and we are constantly meeting with groups of symptoms which can only be brought under one of these designations instead of another by a certain amount of violence, and which do in fact partake of the nature of both. Thus, to take an instance lying at the very threshold of our pathology—ulceration and gangrene in soft parts, or their equivalents caries and necrosis in bone, are names given to what are really parts of the same process—viz. the termination of inflammation in local death. The things are easy enough to distinguish from each other in extreme cases. When the bodies of several vertebræ have, as it were, melted away, without any visible portion of dead bone having ever been known to have exfoliated, there can be no hesitation in saying that here we have caries, not necrosis; when a limb drops off from the trunk black and rotten a few days after an injury, that this is gangrene, not ulceration. But in many cases the two processes are mixed; and many receive different names from equally competent observers. Persons not in the medical profession, with whom the names of diseases are naturally held to represent real entities, are of course scandalised at such differences, and believe that they show either ignorance in the persons or imperfection in the art. They really show nothing except that scientific language cannot acquire the copiousness and variety of the natural processes. This difficulty, however, though it may lead to some confusion and some apparent difference of opinion in the intercourse of practitioners with each other, is not otherwise of much practical moment, since the indications of treatment depend less on accuracy in naming the disease than on sagacity in weighing its chief symptoms. The second is the more important of the two difficulties—viz. the difficulty in ascertaining from the patient what the symptoms really are. Patients who have acquired, as so very many have, a superficial knowledge of medical books, can easily describe the leading symptoms of cancer, uterine disease, stone, &c., which they either feel or imagine they feel. Besides, without the exercise of unusual caution, it is very difficult for the surgeon to avoid putting leading questions on a hypothesis hastily formed; and such questions are pretty sure to be answered in the way he desires. Thus great caution in weighing the patient's assertions, and comparing them with the indications to be drawn from his general condition and from the local appearances, is required in one who is to be a good investigator of symptoms; and with this should be conjoined much deliberation in forming any guess at the diagnosis before the evidence is complete, and much dexterity so to phrase the questions addressed to the patient as not to suggest to him in what way to answer them.

The least unsatisfactory way of arranging the symptoms appears to be in the order of the various organs whose functions such symptoms show to be disturbed. The table printed below (p. 867) will prove one of the most convenient methods of arrangement; and we shall devote in the sequel a few lines to some illustration of the groups of symptoms which are comprised in each of its headings, and of their practical importance in surgical diagnosis.

Nervous system.—The first class of symptoms are those referred to the nervous system—the brain, spinal cord, and nerves. In our table these several parts of the nervous system have been separated from each other; and it is one of the main objects of the diagnostician to effect this separation; that is to say, to determine what symptoms point to the brain, what to the spinal cord, what to the nerves. To illustrate from one of the most common surgical symptoms, loss of motion following on injury. If the loss of motion affects one side of the body only, and is complicated with loss of consciousness, it is a clear indication of limited pressure on the brain. If no loss of consciousness is observed, it is only after the most searching investigation that we can admit that the loss of motion depends on lesion of the brain; yet if the palsy is strictly limited to one side of the body or to one set of nerves, this is the more likely hypothesis. If it affects both sides of the body, but not the intellect, or the facial muscles, or the functions of the nerves of special senses, the lesion must be in the spinal cord, at a level determined by the origin of the nerves of the highest part to which the palsy extends. And we may observe that the more complete the palsy both of motion and sensation, the more extensive must be the pressure on, or disorganisation of, the cord. If, on the contrary, paralysis of the whole body is present with coma, the lesion must affect the brain, and that to a very great extent. If the loss of motion affects only a small part of the body, as a single limb, or a segment of a limb, or a still smaller part, it is clear that the nervous centres themselves are untouched; the lesion has either implicated one or more of the nerves, or else the loss of motion depends on injury to bones, joints, or muscles. The diagnosis depends in a great measure on whether the extent of the paralysis does or does not coincide with the anatomical distribution of the nerves.

Pain.—In the table already referred to, pain, which is of all symptoms the most universal, has been placed under the head of 'nerves;' but this is only an arrangement dictated by convenience. The sense of pain, though always conveyed by the nerves, yet, as a diagnostic indication, comparatively very seldom points to the nervous system itself, but is usually indicative of a morbid state of the organs from which the nerves are derived. Want of space is alone a sufficient obstacle to our discussing the wide question of the value of pain as a symptom of disease.¹ Study of any section in the previous part of this work will show that almost every single affection has its peculiar kind and degree of pain. Such a

¹ The reader may be referred to Mr. Hilton's lectures on Rest and Pain.

study will also prove how much caution is required in estimating this complex and universal symptom; how easily inflammatory pain may be confounded with neuralgic or hysterical, and *vice versâ*. Again, the affections of many organs are signalised by pain in remote parts; and the pain in the knee, which is symptomatic of disease of the hip; the pain in the meatus urethrae, symptomatic of stone or ulceration of the bladder, or sometimes of disease of the kidneys; and generally the great number of instances in which pain referred to the extremity of a nerve is symptomatic of irritation at a higher part of its course.

Organs of sense.—The symptoms referred to the organs of sense are those defects of sight, taste, smell, hearing, and touch, which are almost always present in all diseases, and which point either to organic lesions, functional disturbances, or affections of the nervous system, as the case may be. It would be endless to enumerate them. Let us take a prominent instance. If the student will turn to the essay on DISEASES OF THE EYE he will find an account of the numerous organic lesions of the deeper parts of the eye upon which loss of sight may depend; but loss of sight, even total loss, may be symptomatic merely of some affection of parts remote from the eye, as abscess of the antrum; or may depend on some disease of the brain or the optic nerve; or may be merely an effect of hæmorrhage, or of some depressing habit producing anæmia of the choroid or retina. Most of these symptoms are obviously local, and their interpretation depends in a great measure upon the results of a physical examination of the organ.

Organs of respiration.—The symptoms referred to the respiratory organs, though of less vital importance in surgical than in medical diagnosis, are yet numerous and highly important. We must be content here with one or two illustrations of the truth, that the broad facts, at any rate, if not the minutest phenomena, in this group of symptoms must be as present to the mind of the surgeon, if he would succeed in diagnosis, as to that of the physician; and it must not be forgotten that the diagnosis of surgical affections of the respiratory organs involves often that prompt action on which the instant saving or loss of life depends. Thus, in injuries of the neck, the importance of recognising the dyspnoea which may arise from fracture with displacement of the hyoid bone, and distinguishing it from the numerous other causes which may produce the same effect, is well illustrated by the case related at p. 835. Again, in the same class of cases, it is of the utmost importance to have studied minutely the symptoms produced by the impaction of a foreign body: to distinguish, for example, between the usually paroxysmal dyspnoea, with pain about the thyroid cartilage, but without fever or effusion in the air passages, which are the leading symptoms of a foreign body impacted near the glottis, and the dyspnoea of croup. It is true that the history, if it could be relied on, would make the diagnosis certain; but frequently in these cases the history is unknown or fallacious. To proceed with the same illustration, the reader may consult what has been said in the essay on INJURIES OF THE NECK, about the diagnosis between pneumonic consolidation causing absence of respiratory murmur, and the same phenomenon as the consequence of impaction of a foreign body in one of the main bronchial tubes. So too of the diagnosis between the various sources and kinds of effusion into the pleura after accident (INJURIES OF THE CHEST).

Organs of circulation.—The condition of the organs of circulation is of very great importance in surgical diagnosis; not merely the general state of the pulse, which is always noted as a matter of course in all diseases, medical and surgical, but also the irregularities in the organs of local circulation, arterial, venous, and lymphatic. The various alterations in the arterial circulation caused by an aneurism furnish the most familiar example of the diagnostic signs drawn from the arteries; but there are innumerable others, among which we may instance the sudden loss of pulse in the lower part of a limb, traceable up to a definite point, after an injury, without great ecchymosis, diagnostic of rupture of the inner coats of an artery (vol. i. p. 360); the extraordinary enlargement of arteries, naturally perceptible, which is observed in aneurism by anastomosis (ANEURISM, p. 94); and the peculiar thrill noticed in the pulsation of the larger arteries in anæmic persons. In the venous circulation, some of the most common diagnostic phenomena are the passive enlargement of the veins of a part, with or without œdema, which marks simple obstruction at a higher point of the vessel, whether from coagulation of the blood, or pressure of a tumour; the hardness, redness, and tenderness along the vein, with œdema, which characterise phlebitis (DISEASES OF VEINS); the purring thrill which is felt in large veins from pressure not completely interrupting the current. In the absorbent system, besides the direct evidences of inflammation, and the rare examples of lymphatic fistulae (DISEASES OF THE ABSORBENTS), the chief phenomena to which attention is called in diagnosis are those of simple inflammatory or specific enlargement of the glands.

The errors which may be committed in the interpretation of these symptoms are very numerous. Thus the sudden stoppage of the arterial circulation may be due to embolism and not to accident; the enlarged vessels around a vascular tumour, though they pulsate, may be some of them veins; the thrill referred to anæmia may be due to aneurism; the venous enlargement and œdema may be due to simple retardation of the circulation without positive obstruction; the glandular enlargement to irritation, and not to morbid deposit.

Digestive systems.—Besides the general indications which are to be drawn from the condition of the tongue and of the bowels, the symptoms which refer to the various portions of the alimentary canal occupy a high place in the diagnosis of many surgical ailments. The

¹ This has been particularly noted in arterio-venous aneurism, as in Mr. Moore's case, quoted at vol. iii. p. 90; but I have seen the same thing in cirroid aneurism.

importance of studying the general condition in cases of constipation, in order to the diagnosis between mere mechanical obstruction, acute strangulation, inflammation, and simple inaction, will be appreciated by perusing the observations on that subject (*DISEASES OF THE INTESTINES*). Perhaps we ought also to illustrate the fact, that symptoms referable at first sight to the digestive system may be only reflex phenomena excited by disease or injury of remote parts. The familiar instances are the vomiting, which is symptomatic of early disease of the kidneys, and that which almost always follows on superficial injuries of the brain.

Urinary organs.—The general symptoms which are referred to the urinary organs are less important in surgery than in medicine, these symptoms being mainly confined to the cases of local disease of the organs, but not entirely so. A perusal of the essay on *DISEASES OF THE URINARY ORGANS* will show how numerous and complicated are the general phenomena which the surgeon must master in order to the successful diagnosis of the affections of that system. With reference to the bearing of the urinary phenomena on the general condition of the patient, the most practical example is the frequent disappointment which operating surgeons experience from having neglected to examine the urine before proceeding to operation, and having accidentally performed a serious but avoidable operation on a patient labouring under Bright's disease. It ought to be a fixed rule never to operate on a case of chronic disease of a joint, to extirpate a large tumour, or perform any other operation which is not absolutely inevitable, without a previous careful examination of the urine.

Genital organs.—The functions of the genital organs are disturbed almost exclusively by local diseases; but in the male sex a few general diseases react on the sexual system; an example of which is the atrophy of the testicles which follows mumps in some rare cases, and occasionally succeeds injuries of the head (*DISEASES OF THE MALE ORGANS*). In the diagnosis also of some affections of the brain it is important to note the sexual symptoms; an instance of which is furnished by the perverted sexual appetites which are occasionally symptomatic of epilepsy, and are sometimes regarded as its exciting cause.

Locomotive system.—The locomotive system also furnishes us chiefly with indications comprised under the head of 'Physical Examination,' unless the skin be included under this term. Every symptom connected with this great eliminant organ should be most carefully noted in the first and in all subsequent examinations of the patient. Its heat, dryness, harshness, colour, state of circulation, presence of eruptions, and a host of other particulars too numerous to mention, furnish diagnostic indications of the greatest importance.

Miscellaneous.—Finally, there are some miscellaneous symptoms which cannot be referred to any of the organs of the body, but which may have a considerable influence on the diagnosis of the disease.¹ Thus the condition of restlessness and malaise which accompanies inflammatory fever (vol. i. p. 12); the cachexia which is so striking in some cases of cancer (vol. i. p. 286); the general physiognomy which is to a certain extent characteristic respectively of hysteria (vol. i. p. 235), of struma (vol. i. p. 223), of secondary or constitutional syphilis (*SYPHILIS*, ch. x.); the tendency to symmetrical occurrence in certain diseases, are particulars not to be referred to any distinct system of organs, but which it would be extremely inaccurate to overlook in forming a diagnosis.

III. *Physical Examination.*

Our third elementary division refers to the physical examination of the diseased parts. As this must of course be done by the surgeon's senses, it is convenient to refer to the main particulars under the head of the special sense by which they are perceived: as those which are discovered by the sight—alterations in form, in colour, in volume, in shape, in transparency, and here we must speak of microscopical and other instrumental observations; by the touch—alterations in consistence, in relation, in volume, in pulsation, in mobility; by the hearing; and by the smell.

To these we ought to add chemical examination, in which all the above senses are employed. This method of examination has superseded the disgusting applications which were made of the sense of taste by the medical practitioners of a former day, so that this sense bears no part in diagnosis.

The microscope.—Let us commence this long list of particulars by the visual phenomena; and first of the artificial aids to vision. There are a great many cases in which the surgeon has to make use of the lens in forming his diagnosis. For persons of not very sharp sight, a convex lens is necessary in examining the eye for minute foreign bodies, colourless hairs, crablice, and on other such occasions; and its aid is invaluable in throwing an oblique light into the eye, to examine the capsule of the lens and the contents of the posterior chamber. In skin diseases also a lens is very frequently serviceable.

The use of the microscope in surgical diagnosis is a matter on which practical men differ extremely. Like most other things, in this age of minute research, the microscope has become a speciality in practice, and is therefore decried by those who know little of its use, and exaggerated in importance by those who know little else. But the truth lies, in all these cases, between the extremes. What was at one time believed to be the special province of the microscope in surgical diagnosis—viz. to distinguish between cancer and innocent tumours—has been found to be a problem beyond the unaided powers of the microscope; and, in fact,

¹ A few of these miscellaneous particulars would, in our scheme (p. 867), be referred to under the head of 'Remarks;' the greater number would find a place under the heading 'Aspect.'

as our knowledge of the subject has advanced, the sharp line which was formerly thought to separate malignant and innocent tumours has become less distinct, and it is generally allowed that there are forms of disease which partake of the character of both; yet the value of a good microscopical examination of a tumour has been fully established, though it is now considered as, in many cases, only one of numerous diagnostic signs, to be used along with the history, the naked-eye characters, and the relations of the tumour, in forming a judgment as to its nature; and in that connection of very great importance, although not to be trusted to alone in complicated cases. There are numerous simpler cases of tumour in which microscopical examination alone suffices for diagnosis; but in many of these cases the diagnosis can also be formed without its aid. All this refers to tumours after their removal from the body; but in the living body also it is often possible to remove a very small portion of the tumour for microscopical examination; and such a method is occasionally made use of (vol. i. p. 253).

It is, however, in the examination of the fluids of the body, and of substances discharged or said to be discharged, that the microscope has its most undoubted and most important use. The pathology of urinary affections rests almost as much upon microscopical indications as upon all other methods of examination put together. The presence of pus-globules, of blood-globules, of epithelium, of spermatozoa, of animalcules, of fungi, and of other microscopical objects too numerous to mention, in matter evacuated naturally or artificially, often materially assists or even alone establishes the diagnosis of a case; while innumerable instances of delusion and trickery, in which foreign substances are alleged to have been passed from the mouth, urethra, vagina, and rectum, can only be distinguished from those which are real by its agency; and in the latter case the microscope alone can establish the diagnosis, and thereby perhaps relieve the patient from the fear of an internal tumour, who may have simply passed a shred of undigested meat from his bowels; or announce to one in whom an intussuscepted portion of intestine has been passed the possibility of recovery of health; or, again, warn the friends of another in whom organised and apparently malignant structures may be passed from the anus that these are probably the fragments of some hidden tumour in the bowel; or in whom small fragments of fæces may be detected in the urine, that these prove the existence of a communication between the bowels and bladder (*DISEASES OF THE URINARY ORGANS*, p. 186).

In skin diseases, again, the microscope is indispensable, and has doubtless rendered to that department of pathology the best service which it has received of late, by clearly marking out certain diseases as local, depending on the presence of a parasitic plant or animal, and therefore in all cases curable by simple local measures directed to the destruction of the parasite (vol. ii. p. 924).

The above is not meant as an exhaustive enumeration of the uses of the microscope in surgical diagnosis, but merely as a specimen of its chief applications; and it justifies us in saying that though a man may be a very good surgeon without being anything of a microscopist, yet the highest attainments in diagnosis cannot be within the reach of such a one.

Ophthalmoscope, &c.—Of the diagnostic value of the inventions for examining special organs it is needless to say anything here, since a reference to the essay on *DISEASES OF THE EYE* will suffice for the ophthalmoscope; to *DISEASES OF THE EAR*, for the speculum auris and otoscope; and so on. One word may perhaps be added with respect to one of these instruments, the use of which has excited much contention—the speculum vaginæ. Although there can be no doubt that the examination of women, and especially unmarried women, by this means has been carried to a most unnecessary, indecent, and reprehensible extent, both in this country and elsewhere, its use cannot on that account be dispensed with in appropriate cases. Those which fall under the care of obstetric physicians need not be spoken of here. The main uses of the speculum vaginæ in surgery are to examine the vagina and neck of the uterus for sores, in case of discharge after suspicious intercourse, to examine and expose tumours situated about the os uteri or in the wall of the vagina, and in plastic operations on the vagina.

Alterations in form.—The surgeon ought to be so intimately acquainted with the natural form of every part of the body, that any variation, beyond those natural minute differences which constitute individuality, should arrest his attention at once. Striking instances of the importance of recognising any little alteration in form due to disease may be found in every part of surgery. Thus the slight fulness caused by a strangulated obturator hernia was noticed by Mr. Obré as constituting a difference between the two femoral fossæ, and led him to the happy idea of cutting down upon and liberating the constricted knuckle of intestine (vol. ii. p. 826).

Colour.—The natural colour of parts is composed of the colour of the blood circulating in them, and that of any special pigment they may contain, seen through varying thicknesses of skin or through mucous membrane. Hence variations from the natural hue may be caused by alterations in the mass of blood (pallor and redness), or from detention of blood in the part (lividity and ecchymosis), or from absence or undue deposit of pigment (of the former of which albinism may be taken as an example, of the latter melanosis, the cutaneous maculæ, Addison's disease), or from undue thickening of the cuticle, or cutification of the mucous membrane (as in prolapsus vaginæ).

Volume.—The alterations in the volume of parts depend either on hypertrophy of their natural elements, or on fluid or air effused into their interstices, or on the organisation of inflammatory products, or on the pressure of a new formation. In distinguishing these various particulars from each other, the touch must often come to the assistance of the sight. The hypertrophy of the skin and cellular tissue which constitutes elephantiasis can indeed be recognised by the unaided sight; but in order to distinguish between the thickening of

hypertrophy (so called) of bone, and that of periosteal deposit, the part must be carefully examined with the hand; so of the swelling of cedema or emphysema, of dropsical effusions, of chronic inflammation, and of tumours.

Transparency.—The familiar instance in which transparency is used as the test of the nature of a disease is hydrocele; but in a few other cases it is also employed, as in cysts in the popliteal space occasionally. Opacity also is a phenomenon which is still more frequently noted by the surgeon, and more especially in the humours of the eye.

Consistence.—Alterations in consistence are, amongst all other tactile indications, those from which diagnosis derives most frequent assistance. It would be endless to enumerate all of them; the softening or hardening of different stages or varieties of inflammation, the flabbiness of atrophy, the rounded softness of fat, the boggy feeling of gangrene, are among the most familiar illustrations. Some among these tactile phenomena, however, deserve special mention—viz. emphysema, crepitus, and fluctuation. The first is the peculiar crackling which denotes the presence of air in the cellular tissue. It is a sensation which is often to be met with, and which, when once known, can hardly afterwards fail to be recognised, since there is nothing else exactly like it. It is a kind of crepitus, but cannot be confounded with that sensation. Its most common cause is the escape of air from the respiratory organs into the cellular tissue; and it becomes a sign of importance in wounds or contusions of the neck and injuries of the chest, proving the existence of a wound of the trachea, a fracture or rupture of the larynx or some lower part of the tube, an injury of the lung in cases of fractured ribs, an opening of the pleura or a wound of the lung in penetrating wounds of the chest. But there are many other causes of emphysema. It occurs, though rarely and only to a limited extent, around punctured wounds in any part of the body, or around the opening of an abscess; it may be caused by a wound of any part of the gastro-intestinal tract,¹ and is one of the symptoms of the decomposition of the tissues in gangrene.

Crepitus is a name given by surgeons to the crackling produced by the rubbing of two rough surfaces together. When used in a surgical description without any qualifying adjective, it is intended to signify the rough grating which is produced by the friction of two exposed bony surfaces on each other. It is, therefore, pathognomonic of fracture in a case of recent injury, and of erosion of the cartilages and ulceration of the exposed bony surfaces in a case of joint disease. There is no sensation which can be confounded with this kind of crepitus, nor any ambiguity in the indications to be drawn from it. But besides this fresh rough bony crepitus there are other kinds of crepitus, indicating different conditions, and sometimes rather difficult to make out. The effusion which follows inflammation of the sheath of a tendon produces a kind of crepitus which, in its simplest form, is very easy to distinguish from bony crepitus, it being more of a creaking and a crackling, and obviously produced by the rubbing of soft though somewhat rough surfaces together. As the lymph which produces the sensation becomes drier and harder, the crepitus becomes rougher, but never attains the crisp decided feeling of the crepitus of a recent fracture. But the crepitus of a fracture becomes less crisp and decided as the bony ends get rounded off and coated with soft matter. Hence in injuries which are not recent, it is often difficult, and sometimes impossible, to decide whether the crepitus is from effusion in sheaths of tendons or in joints, or whether it is from fracture. This is particularly the case in the examination of injuries of the shoulder-joint some time after their infliction.

Again, crepitus is produced in old rheumatic disease of the joints; but it is usually easy to distinguish this from the crepitus of caries; for this crepitus, being due to the rubbing of the 'additamentary' pieces of bone on each other, is far freer and more decided, and is obviously caused by portions of bone far more movable than the carious surfaces of a joint can be. I have seen a case in which the sound produced was so loud that it could be distinctly heard at some distance.

The most important of all the diagnostic signs dependent on the touch is *fluctuation*, or the sensation of fluid enclosed in a cavity. This sensation depends on the well-known properties of a fluid—viz. that its particles are movable on each other by the slightest possible force, or, in other words, that a fluid has no cohesion, and that it is incompressible. The most perfect example of this sensation is where thin serum is enclosed in a moderately tense bag, as in the case of a large ascites. In such a case, if a finger be firmly laid upon any part of the bag, the least tap given to any other part of the bag with the fingers of the other hand will cause a distinct wave of fluid to strike the first finger. This is the most usual way of ascertaining fluctuation, and the most certain; but of course it is not available for limited and deep-seated collections. Smaller collections are more usually tested in this manner: alternate pressure is made with the fingers of the two hands; when one finger is pressed down gradually and firmly on the collection of fluid, the latter, being incompressible, transmits the pressure, however slight it may have been, to the other finger; and the sensation of a rounded elastic body is communicated to that finger. This sensation is usually verified by repeating the proceeding with the two hands alternately. Care must be taken not to forget that the elastic reaction of the fluid is perceived, not by the finger which is making active pressure on the tumour, but by that which is lying still on its surface, and therefore to direct the attention to that finger. The perfection of the sensation depends on the fluid being

¹ After a wound of the rectum made in puncture of the bladder per rectum, I have seen emphysema occur and extend up to the chest; so that the feeling of the parietes of the thorax was just what is perceived in cases of fractured ribs.

enclosed in a capsule, and on its not being too deep-seated. When the quantity of fluid is small and deep, another method is often used. This consists in pressing the end of the finger sharply down upon the supposed fluid and suddenly withdrawing it a little, when the wave of fluid which was driven down by the push of the finger will rise up and strike against it.

It is in his accurate perception of fluctuation that the surgeon chiefly shows his tactile accomplishment. But there are many cases in which it is very difficult to decide upon the presence of fluctuation, and many in which it is impossible. Nor need this appear strange if the cause of the sensation be considered. It depends mainly on the fact that the particles of a fluid are movable on each other by the slightest possible force; that it has no cohesion. But this, though true of the pure fluid with which physical reasoning is conversant, as the pure serum in the above instance, is by no means true of the mixed substances sometimes found in the body, of which it is difficult to say whether they are more fluid or solid, and which are very soft and very elastic, but still can hardly be said to have no cohesion or to be incompressible. Thus in some very soft tumours, almost of creamy consistence, such as the most rapidly-growing of the cancerous tumours of the liver, it is impossible, even after they have been removed from the body, to say whether they fluctuate or no; and in the soft mass of granulations into which the synovial membrane of the knee is converted in the gelatiniform degeneration, it is hardly possible to say whether the soft mass does or does not contain one of those limited collections of fluid, so often found there, without the use of the grooved needle.

The latter instrument should always be used in such cases, and will clear up any doubt which the surgeon may feel.

Fluctuation may also be prevented by the thickness of the sac in which the fluid is contained, as in some old hydroceles; or by the extreme tension of the sac preventing the slight displacements which are essential to the undulation of the fluid. This, also, is often noticed in hydrocele. The extreme depth of the collection, again, and the mass of soft parts covering it, or the excessive tension of the cyst wall, may so obscure the sensation as to prevent any confident diagnosis. In order, therefore, to avoid errors as far as possible, and to avoid the appearance of error in circumstances where an accurate diagnosis may be unattainable, the surgeon must be very careful to familiarise himself with the numerous circumstances in which fluid may be present without fluctuation being felt, and, on the other hand, where a deceptive sensation of fluctuation may be elicited from soft and elastic solids.

Relation.—Changes in the natural relations of parts are appreciated chiefly by the touch, though this is often assisted by sight and occasionally by hearing. They chiefly refer to those alterations in the position of prominent points of bone which are produced either by violence in fracture or dislocation, or by muscular action in diseases of joints, and in some affections of bone. In the exploration of the abdomen for tumour or to diagnose the seat of obstruction, and in exploration of the chest with reference to the diagnosis of fluid in the pleura, the ear also comes into play. Beside the actual changes in position, changes in the direction of bones become sometimes of much consequence, as in the diagnosis of dislocations of the shoulder. In some chronic diseases also the relations of parts undergo changes which it is of the utmost importance to anticipate and discover. A notable instance of this is the displacement which the femoral artery sometimes suffers in chronic abscess of the thigh, where the vessel has been wounded by the very care which has been taken to make the incision away from its normal course.

Mobility.—Alterations in mobility depend on the solutions of continuity of bones, ligaments, or fasciæ, on the one hand, whereby parts which ought to be fixed become movable; or, on the other, on chronic inflammation, leading to adhesion or ankylosis, by which movable parts become fixed. The most common illustration of unnatural mobility is that of fracture; and perhaps the most perfect instance of the diagnostic value of loss of natural mobility is in early disease of the hip. When other symptoms might be doubtful, the contrast in mobility of the sound and diseased joint will usually at once clear up the case.

Pulsation.—The alterations in pulsation have been already spoken of, under the symptoms referable to the organs of circulation. Every opportunity should be taken of studying the various kinds of unnatural pulsation which are noticed in diseased vessels, and of verifying by post-mortem examination the morbid conditions on which they may depend; such as the expansive pulsation of ordinary aneurism, the obscure thrill of extravasation depending on ruptured artery, the vibrating and purring thrill of arterio-venous aneurism, the tremulous movement often perceived in the large arteries (chiefly the abdominal aorta) in anæmia.

Sound.—The faculty of hearing is to be employed in many parts of surgical diagnosis, although it may be less important than in medical diagnosis. The use of the stethoscope ought never to be neglected; and every opportunity should be taken for becoming familiar with the healthy and morbid sounds, and for tracing on the dead body the causes upon which the latter depend. The great importance of the bruit in the diagnosis of aneurism is the most striking instance of the employment of the ear in surgery; but it must not be forgotten that aneurisms exist without bruit—in fact, the most numerous class of aneurisms, the thoracic, are very frequently devoid of all sound—and that also (but much more rarely) bruit exists without aneurism, as in a few cases of pulsatile malignant tumour or of tumours pressing on large arteries (ANEURISM, pp. 42–44). In cases of suspected stone, the ear gives the most definite and unmistakable evidence of the presence of the foreign body. In necrosis the ring of the probe against the hard exposed bone is very characteristic. In cases of injury to the thorax auscultation becomes occasionally indispensable and in a few other circumstances the sense of hearing furnishes useful data.

Smell.—The province of this sense in diagnosis is very limited, since, though peculiar odours are associated with many morbid conditions, their other symptoms are quite sufficient to distinguish them, or if not the diagnosis could not be established by the odour. Perhaps favus may be an exception, in which the peculiar mouse-like smell is considered as a characteristic of great value. Some surgeons attribute much importance to the smell of matter discharged from a sinus, as indicating, by a peculiar sanious odour, that it proceeds from a carious surface of bone; but too much stress should not be laid on this.

Chemical examination.—The province of chemistry in establishing the diagnosis of surgical ailments is not very extensive, although in confirming that diagnosis, and in suggesting a rational plan of treatment, it is frequently useful. In urinary diseases, indeed, some chemical examination of the secretion is necessary, and the same may be said in cases of stone; but there are few other instances in which chemical analysis is necessary in the ordinary exigencies of surgery. In medical jurisprudence, however, chemical examination is indispensable in almost every case.

Such are the chief sources of surgical diagnosis; and in order not to overlook any of them in examining the cases which come before him, it is useful for the student at the commencement of his practice to be prepared with a form which may embrace them all, and suggest them to the examiner. Such forms are still more useful in the registration of hospital cases, where reference is so much facilitated by uniformity of system. Accordingly, I have subjoined a form for the registration of cases, which was devised by Dr. Bristowe, to whose kindness I am indebted for its insertion. It has been in use for some years at St. Thomas's Hospital, and is adapted both to medical and surgical cases. An example of a case of either kind is inserted on the form. These forms are intended to serve also as indexes to the detailed notes of the more important cases, which would of course be taken at considerable length and numbered. These detailed notes are to be marked with the same number as is prefixed to the column appropriated to the tabulated case. Thus a reference to the symptoms connected with any of the main headings in the table would at once give all the morbid phenomena connected during life with each organ or system of organs. The post-mortem register is to be arranged on the same plan, and a second reference to it would give all the morbid appearances with which these phenomena are associated. Thus, if the lines are traced horizontally, they give a succinct account of the morbid conditions of the various organs, and references to a more accurate and detailed account of those conditions when necessary; while, if the columns be read vertically, they give a succinct account of the symptoms connected with each particular disease, and (as before) a reference to a more copious account when necessary.

Table for Registration of Medical and Surgical Cases.

ORGANS OF RESPIRATION.	NERVOUS SYSTEM.	1. Disease for which admitted. Duration.	1st attack. 1. Acute rheumatism. 3 weeks.	Acute necrosis of femur. 12 hours.
		2. Associated disease. Duration.	2. Mitral-valve disease.	Pyæmia.
		3. Result.	(1) Cured. (2) Nil.	Dead.
		4. Sex. Age.	F. 16.	M. 5½.
		Occupation.	S. Servant.	Child.
	5. Date of admission. No. of days in hospital.	Date of discharge. Dec. 9. 46 days.	Jan. 24. 11 days.	March 29. April 9.
	Brain.	Want of sleep at times from pain.	No sleep last 6 or 7 days; sensible to last.	
	Spinal cord.		×	
	Nerves.	Pain in many joints (shifting); pain in chest.	Severe pain in right thigh, and left side of face; and for short time in left wrist.	
	Organs of sense.	×	×	
Larynx and trachea.	×	×		
Lungs. Pleuræ.	(Slight cough on admission) ×	(Severe incessant loose cough last three days with short breath. Chest resonant.)		
Expectoration.	×	None.		

Table for Registration of Medical and Surgical Cases (continued).

ORGANS OF CIRCULATION.	Heart.	Increased area of dullness (? effusion). No friction. Syst. m. at apex 11 d. after admission, persistent.	
	Pericardium.		
	Arteries.		P. regular; quick.
	Veins and capillaries.		P. about 160. Imperceptible last day.
	Blood.		
ORGANS OF DIGESTION.	Lymphatic system.		
	Tongue, mouth, and salivary glands.	T. furred on admission and for some time after.	T. moist, but furred. Last 2 or 3 days dry.
	Fauces, pharynx, and œsophagus.		Abscess on L. side in neighbourhood of fauces: opened day before death.
	Peritonæum.		×
	Liver.		No jaundice.
URINARY ORGANS.	Spleen, thymus, thyroid, and S. R. capsules.		
	Stomach.	Thirst and bad appetite when admitted and for some time after. Gastrodynia.	Want of appetite. No sickness.
	Vomitus.		
	Intestines.	×	B. not loose.
	Dejections.		
SEXUAL ORGANS.	Kidneys, &c.		
	Bladder and urethra.		
	Urine.		
	Male organs.		
	Ovaries.		
LOCOMOTIVE ORGANS.	Other female organs.		
	Muscular system.		Very feeble.
	Osseous.		Acute necrosis of nearly whole femur; opened 7th d. Acute necrosis near ramus of jaw. (Lt.) beginning April 1st; opened April 6th.
	Articular, and	Pain, redness, and swelling of many joints.	
	Fibrous systems.		
	Adipose and areolar tissues.		
	Integuments.	Perspiration.	Skin dry all along. A few sudamina.
	Aspect.		Face much flushed at beginning. Aspect of typhus.

Table for Registration of Medical and Surgical Cases (continued).

Operations and date of operations.		
Remarks.	Treated with lemon-juice, then with potash, and occasional hot-baths.	Complained of illness 12 hours only before admission. First symptoms, pain in thigh, coming on without obvious cause.
Name of patient.	M. M. Lack.	J. Scully.
Medical Officer.	Dr. ———	Mr. ———
Reference.	—	—

1. Duration, in the first two lines, is intended to be duration up to the time of entering hospital.
2. Practically, it has been found convenient to place information relating to 'pain' (neuralgic, or of other kind) under the head of 'Nerves.'
3. Where two lines are bracketed the intention is that, in cases where it is impossible conveniently to separate the description of the two or three organs thus bracketed, the combined description shall either extend over the whole space or be limited to the central part of the space.
4. Where more than one organ or tissue is involved in the same disease, the fact should be repeated under each head; thus, when *joint disease* is mentioned under its appropriate heading, it will be often proper to mention *caries* under the head of bones.
5. It is sometimes desirable to give the duration of a symptom, or the time at which it commenced or ceased. This may be conveniently done by making the day of admission the starting-point of reckoning, and by speaking of time in days; thus, duration, 14 d. to 16 d., indicating a duration of three days inclusive, beginning from the 14th day after admission; or 3 d. to 2 d., indicating a duration of five days inclusive, beginning from three days before admission.
6. A line placed under any remark indicates that the condition to which it refers is *important* or *grave*. And the degree of gravity may further be roughly indicated by the degree of thickness of the line.
7. A cross placed in any space indicates that the organ or part to which it refers was ascertained to be healthy.
8. A horizontal line similarly placed indicates that, from some oversight, the condition of the part to which it refers was *not* ascertained.
9. A D. or an M. placed in the corner of a compartment is used to signify that the notes of the case contain a *detailed* description or a detailed *microscopic* account relating to the circumstances contained in the compartment.

The importance of anatomical knowledge and anatomical examination in surgical diagnosis is greater than that of any other of the sources of diagnosis. This will be best illustrated by the following remarks on REGIONAL SURGERY.

REGIONAL SURGERY.

The object of the following pages is to give, in as few words as possible, the main considerations by which the surgeon ought to be guided in distinguishing from each other the affections of the various regions of the body, so far as those considerations depend on the structure of each region. Such a treatise, if completely executed, would embrace all the points at which surgery and anatomy touch each other, and would therefore extend over the greater part of the theory of surgery; but, as most of these points have been fully treated of in the body of this work, it will suffice for me here to give a general view of the leading features of the anatomy of each region, and to dwell more particularly on such diseases¹ as have not found a place in the previous pages.

Of the Head.

The regional anatomy of the scalp and skull is simple. The parts present merely a series of laminæ overlying the cerebrum. These laminæ may, for surgical purposes, be divided into the hairy scalp, including the skin and the tendon of the occipito-frontalis muscle, with the large vessels contained between them; the cellular interspace between this tendon and the pericranium, in which the smaller vessels ramify; the pericranium and skull; and the membranes of the brain. It is unnecessary to attempt here any summary of the well-known points connected with the normal anatomy of these various structures. The point of chief importance in the case of any morbid product in this region is to determine from which of the laminæ it has sprung. This knowledge will of itself frequently determine the nature of the disease, and will at any rate give the most valuable indications as to the possibility of surgical interference.

1. The affections of the superficial layer—the hairy scalp—do not, as a general rule, lead to any difficulties in diagnosis; nor need the reader be detained here by observations on such affections as erysipelas, the cutaneous eruptions, the ordinary forms of nævus, of warts, of innocent tumour, or of cancer—affections which have been treated of in other parts of this

¹ It must be remembered that all injuries will be found in our second volume, described in the same regional classification as that which is here adopted.

work.¹ Two only of the diseases of the scalp and its subcutaneous tissue appear to me to require notice here—viz. the congenital encysted tumour perforating the skull, and some of the rarer forms of vascular pulsatile tumour.

The congenital cutaneous cysts have been referred to, and frequent occurrence in the orbit has been noticed, in the essay on *TUMOURS*, vol. i. p. 259. These cysts sometimes even perforate the skull; and a similar (but usually larger) perforation sometimes exists in the skull, below a tumour resembling in all respects, before removal, the ordinary sebaceous tumour of the scalp, but congenital. It is not to our present purpose to discuss whether the hole in the bone is the result of pressure while it is in a membranous condition, or of original imperfect development. The practical effect is the same—viz. that the tumour lies on the dura mater. The removal of the tumour is not on that account to be absolutely discountenanced, but its important relations call for increased care in the diagnosis and treatment of such of these tumours as are congenital. They are generally brought under the surgeon's notice in childhood. The main questions, in a case of congenital tumour of the scalp, are first, whether the tumour is dermal or encephalic; secondly, allowing it to be dermal, whether it perforates the bone or no. Great care should be taken in examining any congenital tumour lying in any of the ordinary situations of encephalocele; and if such a tumour (not being a *nævus*) partakes in any obvious degree in the respiratory movements, still more if pressure produces any evidence of cerebral disturbance, it is far more wise to abstain from interference, except in case of evident necessity, such as the extension of the growth downwards, and the onset of more evident cerebral symptoms, when an operation may be proposed as a last chance, after its dangers and uncertainties have been clearly set before the child's parents. A tumour in other parts of the scalp, which is rounded, movable, non-vascular, not swelling up with crying, coughing, &c., and in which pressure does not affect the brain, may fairly be pronounced dermal. In a few such tumours, the finger-nail insinuated underneath the base will detect a depression in the skull. Since the depression may be due to perforation of the outer table only,² it does not absolutely contra-indicate operation; but it would be advisable before operating to be satisfied of the decided increase in size of the tumour. Even if no depression can be felt, the skull may still be perforated; so that great caution should always be used.

With respect to the pulsatile tumours of the scalp, which are formed by dilatation of the large arteries below the skin, their anatomy and treatment have been described in the essay on *ANEURISM*, p. 93. I have seen cases in which there was a good deal of difficulty in distinguishing between such aneurismal tumours on the scalp and malignant pulsatile tumour of the skull. The presence of cerebral symptoms on pressure is a clear diagnostic mark, and ought absolutely to forbid any operative interference; but any appearance of morbid action in the skull at the seat of the tumour—more particularly thickening without signs of inflammation—should render the surgeon very cautious in his diagnosis.

2. The occipito-frontalis tendon forms, in an anatomical description, the second of the layers of tissue which protect the brain; but as the surgical affections of this tendon could not be distinguished from those of the skin to which it is firmly attached, it may be neglected in this place. We come then to the cellular interspace between the tendon and the pericranium, to which the tendon stands in the same relation as the deep or muscular fascia does to the cellular interspaces in the other parts of the body. In this interspace the most ordinary affection is the diffuse inflammation so common after scalp-wounds; but this has been already treated of in the essay on *INJURIES OF THE HEAD*. Effusions of blood sometimes take place in the same space, and lead to interesting questions of diagnosis and treatment. Such effusions, as far as I have seen, occur only in early childhood, and are probably always the result of accident, although the occurrence of the blow or fall may not always be known, since no mark may have been left. The fluctuating swelling may extend over the whole scalp, or over a large part of one side of it, being generally more prominent in the temporal region.

When this blood-tumour extends over the whole head, I have seen it mistaken for hydrocephalus—from which, however, there should be no difficulty in distinguishing it, since the fore-

¹ I may perhaps notice that almost all the affections of the scalp are essentially cutaneous, and that the malignant affections are exceedingly rare. Almost all tumours are of the encysted variety; but I have met with a fatty tumour here.

² Mr. Athol Johnstone mentions four cases of these perforating sebaceous tumours. In one, at an operation for sebaceous tumour of the scalp, the bone was found perforated, the dura mater was injured, and the patient died. The case occurred abroad. The preparation was presented to the Royal College of Surgeons by Mr. Prescott Hewett. In two other cases, Mr. Johnstone, in dissecting out sebaceous tumours, found a small perforation in the bone beneath them. No ill consequences occurred. In the fourth case, in an infant who died from other causes, a sebaceous tumour was found lodged in a depression in the bone just above the orbital arch, but not perforating the bone (*Lectures on the Surgery of Childhood*, p. 15). M. Giraudeau has published, in his *Leçons cliniques*, p. 342, an account of a singular case of congenital dermoid tumour of the skull, lying over the anterior fontanelle, and which was long mistaken for a meningocele, in consequence of the peculiar nature of the fluid evacuated from it by puncture. This was so precisely identical with the cerebro-spinal fluid that M. Giraudeau, having punctured a *spina bifida* on the same day, was unable to distinguish any difference between their contents. However, at last, as he made no progress in the treatment of the case by repeated puncture and application of pressure, he determined to lay open the tumour. A flap was formed from the skin of the scalp, and then the tumour was exposed and opened. It was now discovered that there was no communication with the skull, and the cyst was therefore removed entire with perfect success.

head has not the characteristic shape of that disease, the bones are not thrust out, and the skull can generally be detected underneath the fluid. From cephalæmatoma it may be diagnosed by its position, since the latter is confined in ordinary cases to the parietal bone; by the history—the one being congenital, the other usually not; and by the absence of the defined ridge which encircles a cephalæmatoma. When a large artery has been injured, these blood-swellings sometimes pulsate, and increase very rapidly in size, so as to require active treatment. Two courses are then open—either to cut across the swelling, and endeavour to find the wounded vessel; or to tie the vessel at a higher point. The latter course is only possible when pressure on some branch (most probably one of the superficial temporal arteries) will arrest the pulsation. In such a case Mr. Athol Johnstone tied the temporal artery with complete success. The tumour was of large size; and to have laid it completely open and evacuated the contents would have been a severe operation, and possibly might have been accompanied by a good deal of hæmorrhage.

In ordinary cases little treatment is required.¹ Under the use of evaporating lotions, the tumour gradually subsides. But if it continues in a chronic condition, it is justifiable to puncture and empty it; employing at the same time carefully-adjusted pressure. I once treated such a case in this manner, and had the opportunity of dissecting the parts a few months afterwards, the child having died of another disease. I found no traces of the collection of blood, except some decolorised fibrin and a few stratiform clots, bound down by a layer of false membrane.

3. The next layer of tissue is formed by the pericranium and skull. The blood-tumour, which is produced by pressure on the infant's head during delivery, and which is called cephalæmatoma, is smaller than the subaponeurotic extravasations above spoken of, appears in a few hours after birth, is situated on the parietal bone, and is bounded by a distinct ridge. The same ridge, bounding a small round circumscribed collection of fluid, is also familiar to surgeons as a frequent symptom in blows on the head, and a frequent cause of mistake to inexperienced observers, who confound these appearances with those of depressed fracture (see INJURIES OF THE HEAD). Such extravasations from blows always disappear spontaneously; nor is there any more reason for surgical interference in cases of cephalæmatoma.²

The affections of the skull are by far the most frequent and the most important of those which attack this region. They may be divided into—1, the results of simple inflammation, acute or chronic; 2, scrofulous affections; 3, syphilitic affections; 4, tumours, innocent or malignant. Possibly also simple hypertrophy might be added to the list; but I have never been able to satisfy myself of the existence of this affection apart from the results of chronic inflammation.

The diagnosis and treatment of these affections may be thus stated in a tabular form:—

Table of the Chief Surgical Diseases of the Skull and Pericranium.

Disease	Leading symptoms	Diagnosis	Treatment
Acute inflammation: periosteal.	Very severe pain, especially nocturnal; sense of tension; much tenderness; slight swelling, bound down firmly by pericranium.	From tumour of brain or membranes by its more rapid course, and absence of cerebral symptoms. From simple cephalalgia or neuralgia, by the swelling, the persistence and regularity of the symptoms, and sometimes by the constitutional disturbance. From the following, by the absence of suppuration and of symptoms of implication of the brain and membranes. Usually a syphilitic or tubercular history.	If not relieved by iodide of potassium, free incision into swelling, with other constitutional measures.
Acute inflammation: osteal (acute necrosis).	As above; with rapid formation of pus, and probably irritation or suppuration on the other side of the bone, with cerebral symptoms. In rare cases, ulceration of the middle meningeal artery occurs, followed by hemiplegia.	This may be inferred from the preceding.	Free incisions. Trephining is imperative, when symptoms of pressure are clearly marked, and may be justifiable in some cases of mere irritation.
Chronic inflammation and hypertrophy.	Rarely any symptoms: coma has been observed occasionally; but its connection with the state of the skull has not been demonstrated.	Obscure.	No treatment is possible, except for the brain-symptoms, which (as their cause would be obscure) must be treated as they arise.

¹ On the treatment of blood-tumours reference may be made to the essay on CONTUSION, vol. i. p. 295.

² For a more full account of cephalæmatoma the reader is referred to Dr. West's *Lectures on the Diseases of Infancy and Childhood*.

Table of the Chief Surgical Diseases of the Skull and Pericranium (continued).

Disease	Leading symptoms	Diagnosis	Treatment
Neerosis and caries.		Obligatory.	When symptoms of cerebral irritation are present, the bone (especially when not implicating the whole thickness of the skull) may be removed.
Scrofulous affections: ¹ tumour of the skull.	A large hard swelling, on the side of the head, much resembling an exostosis; but accompanied by headache, and symptoms of low inflammation in a scrofulous person.	From diffused exostosis, by the less circumscribed character of the swelling, and the presence of symptoms; but mainly by the effect of treatment.	Blisters or iodine to the part. Iodine, with iron, or cod-liver oil, internally.
Syphilitic affections ¹ of the internal table.	Circumscribed pain in head; irritation of membranes, producing fits, and in rare cases hæmorrhage from middle meningeal artery; with other symptoms of constitutional syphilis.	From syphilitic disease of the brain itself ² only to be diagnosed with certainty by a surgical operation.	When life is seriously threatened it will be justifiable to trephine at the seat of pain; or, in still more rare cases, over the middle meningeal artery. ³
Tumours: innocent: exostosis.	A small and very hard tumour growing very slowly, and unaccompanied by any symptoms except in very rare cases, when the exostosis grows from both tables, or in the orbit when it displaces the globe.	From diseased enlargements of the bone by the presence of symptoms in the latter, and by their less distinct and circumscribed outline.	Operative interference is seldom justifiable.
fibrous or fibro-cystic.	A slowly-growing tumour, more soft than exostosis, and more liable to affect the brain by growing inwards.	From exostosis as above: from cancerous tumours by its less rapid growth, and by the other usual diagnostic marks; from fibrous tumour of the dura mater the diagnosis is obvious before perforation of the skull has taken place, but impossible afterwards.	No interference is permissible. Life may be prolonged many years even after the tumour has produced pressure on the brain and cerebral symptoms.
myeloid or fibro-plastic. malignant.	The same observations apply to the tumour, with the exception that their course is more rapid, and that in all other respects they bear a closer resemblance to malignant disease. Usually circumscribed pain in head; soon followed by the appearance of a tumour, or by softening and pulsation at the seat of pain. The tumour grows rapidly, and soon produces pressure on the brain. The malignant cachexia is usually well marked. The skull is usually thickened around the tumour.	From innocent tumour by its more rapid course, and by the constitutional symptoms. From hernia cerebri, following absorption of the skull (very rare), by the greater violence of the pulsation, the absence of the movements of the brain dependent on the respiration, and the less uniform consistence of the tumour. From vascular tumour (or aneurism by anastomosis), by the cerebral symptoms which are induced by pressure, as well as by the signs of cancer.	No treatment is possible.

4. After the affections of the skull come those diseases of the cranial contents which fall under the notice of the surgeon; that is to say, the tumours projecting through the cranium. Inflammatory affections of the meninges arising from constitutional causes, and the distension of the membranes or of the ventricles of the brain from hydrocephalus, come more properly under the notice of the physician; nor can we here enter upon the wide question of their diagnosis and treatment. The intracranial inflammations which follow injuries are treated of at vol. i. pp. 619 *et seq.* Our present subject will comprise congenital tumours arising from malformation (meningocele and encephalocele), and the numerous forms of tumour which were originally described by Louis as fungous tumours of the dura mater; to which a few words on chronic hydrocephalus must be added, in order to illustrate and explain the surgical operation of paracentesis capitis.

Encephalocele and meningocele are tumours formed by a hernia of the membranes of the

¹ The ordinary constitutional affections are not mentioned, as they are merely the common inflammatory affections *plus* those of the diathesis.

² Such as described and figured by Mr. H. Lee, *Proc. of Med.-Chir. Soc.* vol. iii. p. 283; *Path. Soc. Trans.* vol. x. p. 8.

³ See a case by Mr. H. Lee, *Med. Times and Gaz.* Jan. 29, 1859.

brain through the skull, in one of the parts where the bones are deficient in early life. In encephalocele a portion of brain also lies outside the skull, while in meningocele nothing protrudes except a bag of the membranes filled with subarachnoid fluid.

The tumours so formed are soft, rounded, bluish in colour where covered by thin skin,¹ and from their congenital formation, their colour, and their increase in size when the child cries, are often mistaken for nævus. It is also often difficult to distinguish them from congenital encysted tumours, and sometimes perhaps impossible before operation.²

The pathological anatomy and diagnosis of such tumours is an important and interesting question, to which much attention has been paid by Mr. Prescott Hewett, who has explained the subject very clearly in a course of lectures delivered by him as Professor of Surgery at the College of Surgeons.³ I cannot affect to add anything to the information then first collected on this head, nor in the space at my command even to adequately sum up all the points connected with it; but must be content if I can succeed in indicating those which are of the chief practical importance.

That which appears the leading consideration in the anatomy of these hernial tumours is the condition of the contained organs; since, if these could be known or assumed to be healthy, treatment might be justifiable, and *vice versâ*. It is important, therefore, to know that in hernial tumour of the skull, even if nothing but the membranes protrude, yet there is almost, if not absolutely, always more or less of internal hydrocephalus. In a preparation in the Museum of St. George's Hospital a cyst is seen adhering to the skull by a pedicle which runs down to the anterior fontanelle, the situation of the fontanelle being occupied by a large Wormian bone, which nearly closes it.⁴ The pedicle of the tumour is entirely solid, and the cyst was punctured during life without any detriment, though without benefit. From the length of the pedicle, and the perfect closure of the orifice of communication, there can be no doubt that this tumour might have been removed by operation with fair prospect of success—in fact, the meningocele may be said to have been spontaneously cured. Yet the patient died at the age of six weeks; and on examination there was found a large collection of fluid circumscribed in a part of the arachnoid cavity, and communicating with a dilated lateral ventricle through an opening in the distended corpus callosum. In another preparation in the same Museum, the cyst which is in the occipital region contains no brain, but it leads through a small opening into the cavity of the fourth ventricle, which, as well as the whole ventricular cavity, is enormously dilated. In a case which I treated by iodine injection, and in which the infant died from another cause, the same drosy of the ventricles existed. The case is described and figured in vol. i. of the 'St. George's Hospital Reports,' and the preparation is also in the Museum of the hospital. Therefore in the case of infants, the first point to be remembered is, that there is every probability of the presence of internal hydrocephalus; and it is not until the perfect mental and physical power of the patient is ascertained, by long watching of the case, that the question of surgical treatment ought to be discussed.

The next question of primary importance in the anatomy of such a tumour is whether or no the brain protrudes into the sac. It is only seldom that the pulsations of the brain can be detected;⁵ when this is the case, there can be no doubt of the existence of hernia cerebri; but in ordinary cases, where no such pulsation is found, there is no reason whatever for assuming the absence of the brain from the sac. The mass of fluid lying over it may mask its pulsation, or the protruding portion of brain may be only a small piece rising just up to or just beyond the level of the skull.

The situation of such tumours is very variable. The most common is in the middle line and usually at the back of the head, through an opening in the occipital bone behind the foramen magnum, at the junction of the four centres which form 'the proral portion' of that bone; but any of the membranous portions of the infant skull may yield to the pressure of the fluid collecting inside, and become the seat of the hernia. Thus encephalocele is seen at the root of the nose (between the two halves of the frontal bone), at the anterior or posterior fontanelle, between the frontal and sphenoid or temporal bone, &c. The tumours in the anterior and superior regions of the skull communicate with the lateral ventricle; those in the lateral region with the lateral or the third; those in the occipital region with the fourth ventricle. Hernial tumours have also been found in the base of the skull, probably communicating with the third ventricle.⁶ A short time since a tumour was also presented to the Pathological Society by Dr. Lichtenberg,⁷ which he had removed from a child's mouth, into which it projected from the pharynx, hanging out over the chin, so as to touch the sternum. This turned out to be a hernia of the brain through the base of the skull. The operation of course proved fatal.

The diagnosis of these tumours rests, first, upon their congenital occurrence and position, at one of the membranous portions of the foetal head; next, upon their fluid nature; thirdly, upon their considerable and decided increase in volume or tension with strong expiratory

¹ In these tumours, as in spina bifida, the cutaneous covering may be deficient, and the membranes exposed; but this is still more rare in the head than in the spine. Bruns. *Hand. d. prakt. Chir.* vol. i. p. 701.

² See the case referred to in the note on p. 962.

³ See *St. George's Hospital Reports*, vol. vi. p. 117; also the work of Bruns, above referred to.

⁴ A drawing of the head, taken during life, is also in the Museum.

⁵ As in Mr. Shaw's case, in *Path. Soc. Trans.* vol. ix. p. 1.

⁶ Serres, *Journ. de Chir. par Malgaigne*, 1844, vol. ii. p. 335.

⁷ *Path. Soc. Trans.* vol. xviii. p. 250.

efforts; fourthly, upon their reducibility in part or entirely; and, fifthly, upon their sharing in the motions of the brain. All the three latter marks will be absent from those tumours in which (as in the instance quoted above) the pedicle has been obliterated; but such tumours cannot be accurately diagnosed. Another source of difficulty in diagnosis is that these hernial tumours are occasionally multilocular, and then the fluid is not reducible. This was the case in my patient, referred to above, p. 873. In some other cases also, the diagnosis must be allowed to be very difficult. I have seen a congenital tumour, lying on the root of the nose, and rightly believed to be a common encysted tumour, in which, however, before operation it was impossible to be quite certain of its nature. In another case the hernial tumour was cut into, in mistake for a sebaceous cyst, and a small portion of brain-substance, proved to be so by microscopic examination, was removed. Fortunately no harm ensued.

As to treatment, few surgeons would propose to meddle with a hernial tumour of the brain, knowing it to be such, unless it was distinctly increasing, and the patient's life was obviously imperilled. Unfortunately this is just the case in which there would be least prospect of benefit; since the rapid increase in the tumour depends, in all probability, upon the rapid secretion of fluid from the lining membrane of the ventricles or the arachnoid; and the obliteration of the tumour, if it could be effected, would only hasten the epoch of fatal pressure. But, in some very rare cases, it may be thought justifiable to interfere, even if the tumour is known to be connected with the interior of the skull, since it may be growing so rapidly, and be so near bursting, that it may seem more dangerous to leave it alone than to operate on it. In such cases puncture of the swelling, and carefully adjusted support (rather than pressure) afterwards by means of a pad and bandage, of such materials as may be judged best, are the most advisable operative measures. Tumours of this kind have been removed by excision and ligature, having been mistaken for other growths; but this is a course which should only be knowingly followed in the very rarest cases. In all cases it is advisable to give careful support to the tumour, and to defend it from irritation or injury; and in those tumours which are reducible, if no cerebral symptoms are produced by their reduction, an apparatus should be employed to keep them down to the level of the cranium. This has sometimes been followed by the ossification of the skull-cap and the cure of the disease.¹ Injection of iodine has been tried, as in *spina bifida*, but hitherto, as far as I know, without benefit. Sir James Paget treated a case in this way without any very obvious result, though the disease remained stationary for a length of time afterwards.² I have already referred to a case under my own care, in which also the injection, though frequently repeated, produced no effect on the tumour. In that case, had not the child's life been cut short by an accidental attack of bronchitis, I intended to have attempted the excision of the tumour.

Tumours of the dura mater and diploë.—Since Louis wrote his celebrated memoir on fungous tumours of the dura mater,³ the attention of surgeons has not ceased to be directed to those perforating tumours of the head which he described under that name. It is obvious on reading that paper,⁴ as well as on studying the specimens of such tumours preserved in our museums, that several different kinds of tumours are included under this designation. They differ in nature, some being innocent and some malignant; and in origin, some being originally connected (as Louis thought they all were) with the dura mater, and others with the bone, having usually their primary seat in the diploë; but they agree in certain main leading characteristics, can hardly be diagnosed from each other except under very rare circumstances, and must be carefully distinguished from other forms of tumour. The main features on which their diagnosis is to be founded are, their non-congenital history, which distinguishes them from *navi* and from hernial tumours; and their penetration of the skull, which distinguishes them from aneurism by anastomosis and from ordinary solid tumours. This penetration is manifested by the cerebral symptoms which pressure on their surface produces, and by the pulsation which they receive from the subjacent brain; but it must be remembered that in the case of those of them that are malignant and spring from the diploë, this pulsation may be derived from the vessels of the tumour itself. Sometimes the edge of the opening in the skull can be felt. They are seldom very prominent—often are hardly raised at all above the surface of the skull, but feel like softened pulsating spots in the bone; and they are either single or multiple. Those which are little, if at all, raised, have been sometimes described as aneurisms of the bone.⁵ Those tumours which pulsate actively, and especially those which are multiple, will usually be found to be soft cancer of a very vascular kind springing from the diploë. Those which receive pulsation from the brain are either soft cancer, or fibro-cellular or fibrous tumours, affecting the dura mater, and perhaps originating in it. Some of them, however, affect the bones of the skull to an equal or even greater extent, so that it is not easy to form an opinion as to their origin. A symptom which is often of value as distinctive of tumours penetrating the skull, but which is only met with at an early period, is the presence of a thin crackling parchment-like layer of bone over the tumour.

A description of a rare form of tumour of the skull, secondary to a tumour of the thyroid body, by Mr. Morris, several cases of which are now on record, will be found in the 'Pathological Transactions,' vol. xxxi. p. 259.

¹ Bruns, *op. cit.* p. 715.

² *Path. Soc. Trans.* vol. xvi. p. 12.

³ Translated by Mr. Drewry Ottley in a volume of selections from the Memoirs of the Academy of Surgery of Paris, published by the Sydenham Society.

⁴ Compare the cases numbered 1 and 19.

⁵ *E.g.* by Cruveilhier, *Anat. path.* liv. 33. 4.

Some of these tumours have been met with, which have been entirely reducible within the skull. Nelaton¹ gives a remarkable case, in which several such tumours formed, and disappeared temporarily, but grew again and proved to be cancerous.

If the question of the treatment of such tumours needs discussion, little can be said beyond urging the propriety of not meddling with them. This again might seem almost unnecessary; but it is surprising how often, either from mistakes in diagnosis, or from inability to resist the patient's entreaties, surgeons do commit themselves to an attempt at such operations. Such attempts, however, are unjustifiable on every ground. It has been stated above that these tumours are innocent or malignant. In the former case, an operation will probably hasten death; and in the latter, it will certainly not retard it. The innocent tumours are by no means necessarily fatal.² No operation could be of any avail short of one which would remove the whole of the skull-cap around the diseased parts, and allow of the avulsion of the tumour from the dura mater; and although instances of recovery from such barbarous proceedings are on record,³ they would not now be attempted. But to cut into a tumour of this sort, with no prospect of removing it entirely, is surely still less justifiable. In cancer no operation should ever be thought of, unless there is almost a certainty of removing the whole disease; and this rule is the more absolute, the more vital the organ is in which the disease occurs.

Hydrocephalus.—Surgeons are sometimes consulted with respect to surgical measures in cases of chronic hydrocephalus; and hence it becomes necessary to say something in this place about this disease, as far as relates to its surgical treatment. The acute affections of the brain (encephalitis, acute hydrocephalus, or strumous meningitis, &c.) are so exclusively the province of the physician, that they will not be mentioned here; more especially as it would be impossible to do justice to the subject without more space than is at my command. The effusion in chronic hydrocephalus may be external or internal to the ventricular cavity; it may depend on malformation of the brain, on atrophy, on chronic inflammation, or on injury; and the curability of the disease depends so essentially on these circumstances, that they must be maturely weighed before an opinion for or against surgical interference is given. Cases of external hydrocephalus (i.e. of dropsy of the arachnoid cavity) are usually regarded as less hopeless than those of dropsy of the ventricles. The diagnosis of the two conditions is by no means certain in any case; in fact, Dr. West⁴ says that their symptoms are nearly identical; but some indications can be drawn from the history, and a probable guess at any rate may be formed from the appearance of the eyes. In those cases of hydrocephalus which are congenital there is usually extensive malformation of the brain, and the fluid may be expected to be found in the cavity of the ventricles, although it is not unlikely that there may also be fluid external to the brain. At any rate treatment will be useless. In cases, on the other hand, which can be clearly traced to injury, the probability will be that the fluid is external; and there will be more hope from treatment. In atrophy of the brain, the hydrocephalus will be external; in chronic inflammation, internal; but I know of no symptoms or facts from which these conditions can be diagnosed.

The aspect of a case of hydrocephalus is very peculiar. The fontanelle is widely expanded and often very tense; the sagittal and frontal sutures are opened out, and thus the two halves of the frontal bone are driven outwards, and the frontal eminences project on either hand, giving a peculiar square shape to the head, and great height to the forehead. The base of the skull is driven downwards; and thus the orbital plates of the frontal bone are pushed into the orbit, displacing the eyes, which look outwards and downwards, and are also more prominent than natural. Frequently, also, the eyes have that unsteadiness of action and vacant expression which accompanies partial blindness in infancy. The occiput is driven more or less downwards and backwards. On feeling the head, in an old-standing case, isolated patches of bone (Wormian bones) will often be felt in the sutures. Very large veins ramify over the thin scalp, and the fluid often shines through its attenuated coverings.

Of these characters, the position of the eyes is different in external and internal hydrocephalus, inasmuch as the displacement of the base of the skull depends mainly on accumulation in the ventricles; and therefore the eyes are less likely to be driven out, when the fluid is confined in the cavity of the membranes, since in all recorded cases the accumulation in external hydrocephalus has been limited to the vertex of the skull.⁵

Surgical treatment.—If the child be in fair general health, and not obviously beyond hope of relief, the question occurs whether mechanical means will be of any avail in checking or removing the effusion. I am not aware that any success has attended the use of internal remedies.

¹ *Path. Chir.* vol. ii. p. 631.

² There is in St. George's Hospital Museum a preparation showing a fibrous tumour of the skull and dura mater, which had perforated the latter membrane and was lying on the brain, from which it received a very decided pulsation. The patient suffered from occasional fits, loss of memory, vertigo, and sickness; but he survived the appearance of the tumour more than fifteen years; and finally died, at a tolerably advanced age, of a disease quite unconnected with that on the skull.

³ Louis, *op. cit.* obs. 19, p. 114; a case in which a piece of bone, six and a half inches in circumference, was removed by the application of numerous crowns of trephine on several occasions; and a 'fungous substance' was said to have been removed from the dura mater. The whole description and history, however, seem to show that this was merely a case of caries of the skull, and the fungous substance only the product of inflammation.

⁴ *Lectures on the Diseases of Infancy and Childhood*, lect. ix.

⁵ This point was elaborated by Mr. Prescott Hewett in his lectures at the Royal College of Surgeons.

I have often made patient trial of mercury, and believe it to be quite inert, as far as procuring any reabsorption of the fluid goes. Nor can I say that I have found any benefit from mercurial or other applications to the scalp. Pressure on the skull, or puncture of the fluid collection (paracentesis capitis), are the only means which hold out any rational prospect of benefit; and although I cannot recall any case of success under my own observation, I do not dissuade their use whenever the disease is not congenital, or accompanied by other malformation, or complicated with symptoms of active disease. There seems more prospect of benefit from using these measures simultaneously than separately. In puncture of the skull a point must be selected away from the middle line, in order to avoid the sinus, and away from any large vein. A very fine trocar should be used, and only a very small quantity (say two ounces) of fluid withdrawn, careful compression of both sides of the skull being maintained meanwhile. If convulsions come on, the instrument should be at once withdrawn. A cap should be in readiness, made of sheet-caoutchouc, perforated with small round holes, to avoid heat of the head, and while unstretched slightly too small for the head; and this should be applied directly on the withdrawal of the cannula. If the child's condition is improved, or not made worse, by the first puncture, it can be repeated in a few days, but not in the same place. The operation, however, is often followed by convulsions; and it has seemed to hasten death. Still the disease itself is so miserable and fatal, that anything which holds out a prospect of relief, and does not entail suffering, may be tried. I have sometimes contemplated the possibility of injecting iodine in this disease, but have not hitherto met with a case in which I could think the attempt justifiable.

Almost every case of chronic hydrocephalus proves fatal, if the effusion is so extensive as to cause obvious increase in the size of the skull. At the same time, a few patients survive to maturity, as the man (Cardinal) whose bust is in most pathological museums, and who lived to the age of 29; and in a few cases the affection disappears by spontaneous cure. In some cases, where, without obvious malformation, there is some defect of intellect or temper, the only post-mortem appearance has been internal hydrocephalus to a slight amount. Such was the case in the body of a youth, otherwise well formed and healthy, who was beaten to death by his schoolmaster a few years ago. The brain was well formed; but the ventricles large, slightly compressing the convolutions, and containing a large quantity of limpid serum.

A case was related to the 'Royal Medical and Chirurgical Society,' by Dr. Thompson of Newcastle-on-Tyne, in which a collection of fluid formed after a contusion received by an infant two weeks old, and gradually produced all the symptoms of external hydrocephalus. The head was twice punctured. At the first operation, clear watery fluid was drawn off, and continued to ooze from the puncture for some time. Convulsions occurred ten days after the operation, attributed to the cutting of some teeth. Another puncture, five weeks after the former, proved permanently successful; the fluid drawn off was more milky. Neither specimen seems to have been analysed.¹

The Face.

The regional surgery of the face demands but little consideration in this place, since the greater number of its affections have been spoken of in other parts of the work. Thus the operations for remedying the deformities which are so frequent in this part will be found treated of under the head of PLASTIC SURGERY; salivary fistula under INJURIES OF THE FACE; and all the various affections of the MOUTH, JAWS, and GUMS under those headings. The tumours situated in the cheek and parotid region, however, have not been elsewhere described; and as they are of frequent occurrence, and of much surgical interest, we must devote a little space to this topic.

Tumours.—The most frequent tumour in the cheek is the common sebaceous cyst, which in male subjects is developed in front of the ear (*i.e.* in the hairy part of the face), only a little less oftener than it is found in the hairy scalp. Its diagnosis is obvious, and its treatment easy; but when it dips down more deeply than usual, and lies near Stenson's duct, care must be taken, in dissecting it out, to keep close to the cyst. These cysts can in this region be removed most readily by slitting them across with the skin; and this plan also involves a more limited incision, which is an important consideration here. The incision should be horizontal, and the knife be kept as much as possible in the horizontal direction, in order not to wound the duct or nerve.

Cysts of other kinds are also occasionally seen.² I have treated one in the substance of the cheek, in a child five years of age, attributed to a blow received in very early infancy, and containing fluid exactly resembling blood. Iodine injection was practised, and I believe successfully; but the patient was lost sight of before the event of the case could be positively affirmed. I have also seen watery cysts in the neighbourhood of the parotid gland; but the most frequent tumour in this part is the *glandular parotid tumour*. This is a firm hard lump,

¹ *Med. Chir. Proc.* June 28, 1864.

² Short references to several cases of cysts of various kinds situated in the face may be found in Jamain, *Manuel de Pathologie et de Clinique chir.* vol. ii. p. 42. Care must be taken to distinguish between a watery cyst and a collection of fluid in the expanded duct of the parotid from wound or obstruction of that duct. Cases of this latter affection will be found described by Jarjavay, *Mém. de la Soc. de Chir.* vol. iii. p. 492. It will be recognised by the position of the swelling, its increase in volume during mastication (when possibly some slight escape of saliva may take place through minute openings on the skin of the cheek), and the dryness of that side of the mouth. The treatment consists in re-establishing the opening into the mouth.

situated generally below and behind the lobe of the ear, but sometimes in front of it, and is probably developed in one of the absorbent glands which lie over the parotid in that situation;¹ or it is supposed by some authors to be occasionally developed in the fibrous envelope of the gland. It bears a striking analogy to those glandular (adenoid) tumours which lie in the neighbourhood of other glands, such as the mammary and the prostate, and is described by a recent French author as a hypertrophy of the parotid.² It grows slowly, displacing the parotid gland, pressing more or less on the parts contained in that gland, and sometimes burying itself deeply behind the ramus of the jaw. Its structure is very firm and solid, consisting usually of well-formed fibrous tissue, mixed with glandular elements, in which portions of cartilage, and often more or less myxoma tissue, are often found; and it frequently has one or more cysts in its interior. Its continued growth produces deformity, frequently loss of hearing or difficulty of mastication, and more rarely palsy of the features on the affected side; and so its removal is very desirable. But the operation is often attended with unpleasant, and sometimes even dangerous, consequences, from lesion of the large vessels and of the facial nerve; therefore some caution should be exercised, both in giving an opinion on the probable result of the case, and in operating on the tumour. As with tumours in the neck, the main element of safety in these operations is to have a very free access to the surface of the tumour in some position where it can be approached safely, which in the parotid tumour will be at its posterior edge. For this purpose a T-shaped incision will be most convenient, the vertical line passing down the posterior edge of the tumour. The growth will generally be found enclosed in a distinct capsule; and if the latter be freely opened, and the knife kept close upon and directed towards the surface of the tumour, the operation is usually completed without accident.³ But the position of the facial nerve, the external carotid artery, and the large trunk which forms the commencement of the external jugular vein, must be carefully kept in mind. I have often seen each of these parts wounded; and, indeed, it may be mechanically impossible to remove the tumour without dividing the nerve. If the artery is wounded, this happens generally in the last stage of the dissection, and there is frequently no difficulty in securing it. When the tumour passes into the neck, its removal is of course more hazardous; as also when it dips under the ramus of the lower jaw. If the trunk or a main branch of the facial nerve has been severed, a most unpleasant drawing of the features is the immediate result; and this condition is very likely to remain permanently. It is true that simple wounds of nerves rapidly heal, and often without loss of function; but the division of a nerve in the cavity of a large wound, where the cut ends may not be in contact, or may become separated afterwards by inflammatory products, is another matter.⁴ However, palsy of the nerve may be produced by inflammation occurring in its neighbourhood, without any wound, or with only a slight injury to the nerve itself; and this palsy will be transient. The circumstance will be distinguished by the fact of the palsy not occurring instantaneously after the operation, and being at first incomplete. If the tumour should extend far forward, Stenson's duct is endangered, and may be divided, leading to a salivary fistula, which, however, if treated in the usual way, may prove curable.⁵

These tumours are sometimes observed to recur, and in all probability this is usually in consequence of a portion having been left behind at the former operation; but the recurrence of adenoid tumours in other parts⁶ should make us hesitate to admit that this is the only cause. The most interesting case is the one recorded by Langenbeck.⁷ Here the original tumour was clearly distinguished by its difference of appearance from the substance of the gland in which it was imbedded. After a year it recurred. The extirpation was then difficult, and involved a wound of the facial nerve, and persistent facial paralysis. Five years afterwards the patient presented himself with a tumour beneath the sterno-mastoid as large as a child's head, which adhered to the periosteum of the inside of the jaw, passed down on to the styloid process, rested on the sheath of the common carotid artery, and had the internal jugular vein imbedded in it. The extirpation of this tumour was nevertheless successfully effected, and even without injury to the vein.

The other tumours of the face derive too few peculiar characters from their anatomical relations to detain us at present. I would, however, just mention a very singular tumour, spoken of by MM. Bérard and Denonvilliers ('Compend. de Chir.' iii. 99), formed apparently by a distension of the frontal sinus, producing intense pain, displacement of the eye, and a large accumulation of gas in the superficial parts of the face communicating with the neck. The patient was under the care of M. Jarjavay, and recovered after the tumour had been laid open and had suppurated.

¹ See the figure by Mascagni of the lymphatic system of the face, reproduced in Gray's *Anatomy*, 5th ed. p. 445.

² Bauchet, in *Mém. de la Soc. de Chir.* v. 289.

³ A case related by Vanzetti, 'Observation de Tumeur fibreuse de la parotide,' *Bull. de la Soc. anat. de Paris*, 1844, p. 40, in which the tumour was of very large size, and passed inside of the ramus of the jaw, will show the importance of recognising and keeping within this capsule. When this is done, large portions can be detached without any cutting; and the capsule is sure to separate the operator from any important structure which may be endangered. See also Liston, *Prac. Surg.* 4th ed. p. 324.

⁴ In a case related by Bauchet, *op. cit.* p. 337, the operator, M. Lenoir, having recognised the two ends of the facial nerve, which he had divided, placed them in contact, and the paralysis was only transient.

⁵ Salivary fistula occurred in 3, and facial paralysis in 3, out of 11 such operations related by M. Bauchet.

⁶ See DISEASES OF THE BREAST, p. 442.

⁷ *Archiv f. klin. Chirurgie*, i. 4.

Finally, I ought perhaps to say a few words about those great tumours which sometimes spring from the bones of the face, and produce horrible deformity by driving the eyes out, distorting the features, &c. They have been alluded to in the essay on *DISEASES OF THE MOUTH*, as 'hypertrophies of the upper jaw-bones,' the name by which Mr. Stanley described them. Some of them are of this nature; others are diffused enchondromata, springing from the base of the skull. In a very remarkable specimen, in St. George's Hospital Museum, described and figured by the writer in 'Path. Soc. Trans.' vol. x. p. 250, the tumour almost fills the anterior fossa of the base of the skull, and has pushed both eyeballs completely out of the orbits, besides filling the nasal cavity and projecting on the cheeks. When such tumours have been less extensive, and free from cerebral symptoms, attempts have been made to remove them;¹ but these have failed in consequence of the extent of attachment of the tumour to the base of the skull. Very careful examination is therefore necessary before the surgeon commits himself to any such attempt; and it is only when there is sufficient reason for believing that the tumour has a comparatively narrow attachment, that the attempt holds out much encouragement. If the eyes are widely separated, and pretty equidistant from the middle line; if the parts of the tumour within reach are fixed to the bones of the face; and if ossification or calcification seems to be proceeding extensively in the mass—the obstacles to the operation will probably be found insuperable; nevertheless, it is quite possible that the removal of the cartilaginous surface of the tumour may at any rate arrest its growth; and in these frightful cases it is justifiable to run considerable risks. The absence of dilatation of the face from outward pressure of the malar or superior maxillary bones is a favourable diagnostic indication, as tending to show that the nasal cavities are alone implicated. But even then the base of the tumour may be so extensive or so remote that its complete removal is impossible.

The *opening of the mouth* is occasionally much narrowed and displaced. This occurs as a consequence of ulcerative and gangrenous affections of the soft parts, and sometimes also of the bones; from lupus, rodent, or cancerous ulcer of the face, mercurial ulceration, cancrum oris, burns, or wounds which have taken on an unhealthy action. The deformity is excessive; nutrition is sometimes seriously impaired from the limitation of the movements of the jaw as well as the narrowing of the opening of the mouth; and an attempt at cure is imperative. In all such cases much care ought to be taken to ascertain, if possible, the condition of the parts inside the mouth. Sometimes the gums and cheek are incorporated, or the jaws may be partially ankylosed. Frequently large masses of foul deposit exist around the teeth. If the parts within the mouth are very firmly adherent, and the mucous membrane greatly altered from its natural condition and cicatrised, there is not much hope of success from surgical operation; but if the mucous membrane be movable on the skin, an incision may be made outwards from the corner of the opening, a portion of the skin may be removed, leaving the mucous membrane, which is then to be divided, and the mucous flaps stitched to the edges of the skin. In this manner, if primary union be obtained, there is the less risk of the opening recontracting. Or, if this be impossible, two flaps of skin may be drawn down from the face and united to the edges of the incision, with their cutaneous surfaces towards each other. If these will unite kindly to the raw surfaces left by the incision, the re-adhesion of the edges of the wound, and its consequent cicatrization, with reproduction of the deformity, may possibly be obviated. But it must be allowed that the parts are often so diseased and scarred both around the opening and for a long distance on the cheek, that neither of these plans is feasible. In the only case in which I have had an opportunity of trying this proceeding,² the substance around the oral opening was so completely altered in character, that it was impossible to separate mucous membrane from skin; while the parts on the cheek and chin were so changed from their natural condition, that it would have been hopeless to endeavour to transplant skin. Under such circumstances, as also when the parts inside are extensively cicatrised, it would be well to give a patient trial to dilatation by means of conical pads of ivory, compressed box-wood, or some similar smooth substance, so contrived as to make gradually increasing pressure against the opening.³

Inflammatory affections about the parotid or other salivary glands are of very frequent occurrence; especially the trivial contagious affection so common in children called the mumps, which consists in swelling of and around the parotid, submaxillary, and sublingual glands, accompanied with some pain and stiffness in using the jaw. It is ordinarily confined to one side at first; but is very liable to spread to the other. Generally it is quite devoid of danger, or, in fact, of any importance, and requires no treatment beyond a warm fomentation or poultice, with perhaps some saline diaphoretic. But cases in which the inflammation has been transferred (by metastasis, as the term is) to the testicle has been already referred to (p. 517); and the same thing takes place in the female mamma, though more rarely; while metastasis to the brain appears to have been noticed. These complications must be treated in the same way as similar inflammations excited by other causes.

¹ Viz. once by Mr. Morgan of Guy's Hospital, and again by Mr. Moore; the model of the head in the former case is in the Museum of Guy's Hospital.

² The case was reported by Mr. Sercombe, in *Med.-Chir. Trans.* vol. xxxix. p. 95.

³ See the essay on *INJURIES OF THE FACE*, vol. i. p. 713. On this subject consult Wernher, *Handbuch der allgemeinen Chirurgie*, vol. iv. p. 18.

Inflammation of these parts may also be excited by the use of sialogogue medicines, especially mercury; or inflammation accompanied by salivation may occur spontaneously. In the former case the disuse of the irritant, with the frequent employment of astringent gargles, and the internal administration of tonics with chlorate of potash and nutritious fluid diet, are the measures indicated. Spontaneous inflammation of the salivary glands is generally more rebellious to treatment: the general health and the local condition of the gums should be the first objects of inquiry and attention. If there be much swelling and tenderness about the parotid, leeches may be of service. When the inflammation has become chronic, the local application of iodine, or the careful use of mercurial ointments, is indicated.

These complaints are all of them liable to end in abscess; and such abscesses, bound down by the firm fascia which covers the parotid gland, are both painful in themselves and distressing, from the impediment they offer to mastication. They have been also known to burst into the meatus auditorius; and to burrow about to a great extent in the neck. They should be opened early; but it is desirable, in all affections of the face and its neighbourhood, to avoid too free incisions; and if the opening be made sufficiently early, a mere puncture through the skin, with a tolerably free division of the subcutaneous parts, including the fascia, will suffice. If a more extensive incision be required, the natural foldings of the skin must be studied, and its direction be made to correspond.

Abscesses are occasionally produced by calculi imbedded in the duct of the parotid gland. The existence of such calculi in some cases of ranula has been already noticed, vol. ii. p. 573. Their composition is phosphate of lime, with a little triple phosphate. If such an abscess be allowed to burst externally or be opened on the cheek, a salivary fistula will probably result. Hence it is important to open the abscess and remove the foreign body (which can easily be felt) from the interior of the mouth. Abscess in the parotid gland is a serious and not very uncommon complication of some forms of blood-poisoning, the treatment of which must be conducted on similar principles to those just mentioned.

The face is liable to be attacked by epithelial, rodent, and lupous ulceration. The nature of these various forms of disease has been discussed in other essays, and their diagnosis and treatment has been, as far as possible, pointed out. But the interesting question remains for discussion in this place, what resources has operative surgery in the treatment of these affections when they attack the face? Few surgeons of experience can have been without opportunities of witnessing the frightful condition which is induced by cancrioid and rodent ulceration of the face. The features gradually and slowly yield to the progress of the disease; the soft parts are eaten away; the bones crumble, or become necrosed; the nose and mouth, and sometimes the orbit also, fall into one cavity, and yet the patient lives on, though frequently suffering terrible pain; and although presenting a condition of incurable mutilation, which no feelings of humanity can prevent our regarding with some amount of repugnance. The disease is too generally regarded as a hopeless one, and the surgeon is glad to escape from his patient. Yet, in the case of rodent ulcer almost certainly, and in many of the cases regarded as epithelioma very probably, if the disease were destroyed entirely and in its whole extent, the patient would be restored to good general health, the edges would cicatrise, and the gap in his features could be filled up by some of the many kinds of mask, or false features, which the ingenuity of our dentists and mechanicians has produced.¹ Much encouragement for boldness in operating on such cases when occurring in the face may be drawn from the treatise of the late Mr. Moore on 'Rodent Cancer,' where some striking instances of the success of the treatment are detailed. I may be allowed to cite the following passage (p. 52):—"The knife and caustic may be so combined that the surgeon shall extirpate the disease in a very advanced stage, protecting the patient absolutely from pain and shock by the use of chloroform, and the subcutaneous injection of morphia, and supplying by a suitable mask the shrunken gap which is left after the cicatrization of the wound. I first found how far such an operation could be carried in a case of Mary H., in which I removed all the margin and contents of the right orbit, with the bridge of the nose, and laid a paste of the chloride of zinc on the freshly-cut surface, which still presented fragments of the disease in the exposed portions of the bones. Before the patient awoke from the effects of the chloroform, I injected morphia beneath the skin, and under its influence she remained asleep for six hours, and awoke free from pain. In five weeks the inodorous slough came away, the wound healed, and the patient lived three years in comfort, wearing a vulcanite mask, which was skilfully moulded and painted to represent the defective features. Another patient who was under the care of Mr. De Morgan, after as extensive an operation, completely recovered, and afterwards not unfrequently enjoyed a day's shooting. . . . The advantage of this method of treating rodent cancer appears to consist in the completeness of the caustic

¹ Much freedom in operating on these cases of epithelial ulceration is justifiable, in order to relieve the wearing pain which it occasions, even if for no other motive. A man above eighty years of age came under my care some years ago, begging for relief from the pain of an extensive epithelial ulcer of the eyelids. He was labouring under disease of the heart, and could not safely be brought under the influence of chloroform, but he had great courage, and submitted to the operation without complaint. I removed the whole of the lower and about half of the upper eyelid, down to the bone, and filled up the gap with a flap from the cheek. This united perfectly. He was freed from his distress, and no return of the disease took place up to the time of his death, which occurred from the heart disease, in his sleep, about half a year after the operation.

action of the chloride of zinc. There is no expenditure of it upon the dense margin of the disease, but it acts directly upon the soft tissues which are exposed by the incisions. These apparently healthy, but really morbid parts, are readily permeable by the caustic, and they can be destroyed to any depth which may be deemed requisite. Volkmann's sharp spoon supplies a valuable aid in the removal of these as well as of lupous diseases of the face and other parts.

The Neck.

The chief points in the surgical anatomy of the neck are connected with the arrangement of the cervical fascia. This membrane has an arrangement in the neck somewhat similar to that which prevails in the limbs, although more complicated; that is to say, it consists of a system of long sheaths or tubes, which surround the muscles and the chief vessels, together with the trachea, and which take attachment to the bony framework of the part—viz. to the lower jaw above, the clavicle and ribs below, and the spinal column at the back. As the fascia lata, if traced upwards, will be found continuous with the iliac fascia around the femoral vessels, so the cervical fascia may be traced behind the sternum and ribs, till it becomes continuous with the outer layer of the pericardium. Now, the extensive connections of this fascia explain how it is that tumours, lying beneath it in the neck, may grow to such a size, may pass down in so many directions, and may implicate such important parts before they have made enough progress externally to induce the patient to apply for their removal; how spreading affections, such as diffuse inflammation or abscess, may pass down the cellular tissue of the thorax, and the disease thus be withdrawn from all possibility of successful treatment; and therefore why surgeons always regard operations conducted below the cervical fascia with apprehension, both on account of their immediate dangers, and their possible complications.

The affections which attack the parts superficial to the cervical fascia do not call for much notice here. Sometimes, however, superficial tumours may be met with in this situation, which, either by the negligence of the patient, or the ignorance of those whom he has consulted, have been allowed to grow to a great size. A striking instance of this is the fatty tumour figured in Liston's 'Practical Surgery' (4th ed. p. 321), and which was as large as the patient's head.¹ When above the fascia, these growths, whatever be their size, may be removed with as little risk as tumours of the same size in any other parts. The signs indicative of their being situated over the fascia will be the readiness with which the finger can be inserted beneath them and then passed between their base and the larynx, or the sternomastoid muscle, their mobility and the dimpling of the skin when moved over them, which is usually noticed in fatty tumours.

We pass on to consider that peculiar form of watery cyst which is described as *hydrocele of the neck*. This tumour is sometimes superficial to the cervical fascia, but usually more deeply seated; sometimes congenital, at others an affection of later life;² sometimes simply cystic, at others of a more complex anatomy. The first point to be established is the character of the tumour, and the next its situation. Simple watery cysts, or true hydroceles, are such as are destitute of all solid base, and contain frequently a purely watery fluid; at other times, more or less of the constituents of the blood may be found mixed with the fluid (hæmatocele). The cyst is usually single. From this type there are numerous variations: thus, the occurrence of a congenital tumour, consisting of one or two cysts, with a solid basis, is sufficiently common; and the number of the cysts, as well as the quantity of solid matter, may be increased until the whole side of the neck is filled with a solid tumour, in which cysts with various contents are scattered. This latter affection is, I believe, always congenital.³

The neck is undoubtedly the favourite situation for congenital tumours, and those which occur congenitally in this region are almost always of the polycystic variety. The question of chief importance in their diagnosis and treatment refers to the proportions of solid substance which they contain. They usually extend deeply into the part, passing underneath the cervical fascia into the loose cellular tissue supporting the carotid sheath, the trachea, and œsophagus, and very often will be found to have completely surrounded one or more of these structures. I have seen cases in which the morbid growth had affected the structure of the tongue as well as the cellular tissues of the neck.

In the front of the neck these congenital tumours appear always to originate in the loose cellular tissue beneath the cervical fascia, and to make their way through that membrane and beneath the skin simply by pressure. I have never seen a case in the front of the neck which did not bear out Mr. T. Smith's assertion,⁴ that congenital cystic tumours are always situated beneath the muscular fascia, although many of them have a subcutaneous portion.

The carotid triangle is a favourite situation for these tumours. In one instance under my care, the solid portion of the tumour contained such numerous and variously shaped cells as to raise a suspicion of malignancy.

¹ See also a case in *Path. Soc. Trans.* vol. xi. p. 256.

² Gurte, *Ueber die Cystengeschwülste des Halses*, p. 210, says that very few of the recorded cases have been congenital.

³ See, on the subject of these compound cystic tumours of the neck, a paper by Mr. Cæsar Hawkins in *Med.-Chir. Trans.* vol. xxii.; one by the author 'On Congenital Tumours,' *Lancet*, May 21 and 28, 1864; and see also the section on 'Congenital Tumours' in the essay on the SURGERY OF CHILDHOOD, p. 801. See also a paper by Mr. T. Smith, *Clin. Trans.* vol. xiii. p. 197, on two cases of congenital cystic hygroma.

⁴ In his paper in *St. Bartholomew's Hospital Reports*, vol. ii.

The diagnosis of the affection has been obvious in all the cases which I have seen.¹ The only ambiguity which I have met with is as to whether hardening around the base of a cyst depended on the presence of a solid tumour, or was due merely to the pressure of the cyst. The doubt would much influence our prognosis, though perhaps it would not make any difference in the treatment adopted at the commencement. I ought also to mention that Von Ammon² describes and figures tumours, apparently of this compound cystic nature, as congenital enlargements of the thyroid body. I have not seen any which were developed in that organ. The diagnosis would be easily made by watching the effort of swallowing on the position of the tumour, and by tracing, if possible, the muscles connected with the thyroid cartilage and under border of the hyoid bone.

As to the prognosis and treatment of these cases. The simple hydroceles advance somewhat rapidly; they may grow, however, to a large size without making pressure on the deep-seated organs, and treatment may be adopted with much prospect of success.³ I have seen in an instance of simple hydrocele a single injection of tincture of iodine followed by complete cure, although the cyst was of large size. The patient was an infant, under Mr. Prescott Hewett's care, and on examining the parts afterwards nothing was to be felt but the hardened remains of the cyst, while the distended skin hung in a loose fold over the clavicle. In other cases, even when some thickening existed at the base of the cyst, I have seen iodine as completely, though less rapidly, successful. But where there is solid matter as well as cysts iodine injection does not usually succeed, and then it may be justifiable to resort to setons, though the measure is not without danger,⁴ or to make a free incision into the cyst or cysts, and endeavour to procure their obliteration by the granulating process, or to cut a large piece of the cyst out, or even to destroy the whole mass by the application of arrows of caustic, as recommended by Maisonneuve (see MINOR SURGERY). But in cases which are suitable for removal, extirpation, though of course it presents more immediate risks, seems ultimately the less dangerous course. On this subject the reader is referred to what is said below on the general question of removing tumours of the neck.⁵ Any surgical interference with the cases of cystic hygroma, referred to above, is liable to be followed by diffuse inflammation, which involves great danger to the child.

Deep sebaceous cysts.—The nature of the tumours which are so often found in the deeper parts of the neck—that is to say, lying in or below the deep cervical fascia—is a matter of great importance in their surgical treatment. Langenbeck⁶ has pointed out that dermoid cysts in this region, contrary to what takes place in other parts of the body, are frequently found below the deep fascia, and not unfrequently adhere to the sheath of the cervical vessels, or are possibly developed in the substance of the sheath.⁷ As to diagnosis from cysts of a different kind, Langenbeck points out that in all the recorded instances these deep sebaceous cysts have been situated in the neighbourhood of the larynx, or of the great vessels of the neck, above the omohyoid muscle; that in the latter situation they are perceptible from the mouth, and the peculiar fluctuation of the pulpy fluid they contain may be felt by placing one finger in the mouth and another on the skin; that the swelling is of a round or oval form, and perfectly smooth; that they may often be made to share the pulsation of the carotid by

¹ M. Michaux (*Bull. de l'Acad. Roy. de Méd. de Belgique*, vol. xii., and *Gaz. des Hôp.* No. 36, 1853, pp. 136, 144, 147) relates several cases of hæmatocoele of the neck, in some of which the diagnosis was so obscure that nothing but puncture would clear up the difficulty. In most cases the diagnosis from aneurism may easily be made, even if the tumour should have the arterial pulsation, by remarking that though pressure on the carotid below suspends the pulsation of the tumour, it leaves it equally full, tense, and distinctly fluctuating, as also by studying the bruit. See a case reported by Gurlt, *op. cit.* p. 225.

² *Die angeborenen chirurgischen Krankheiten*, tab. xiii. figs. 1, 2, 3; tab. xxiii. figs. 7 to 11 incl.

³ A case is reported by Werner (*Die angeborenen Cysten-Hygrome*, Giessen, 1843, p. 3), where openings formed spontaneously in the tumour, the fluid oozed away, and a natural cure resulted. Another is recorded by Mr. B. Phillips, *Med.-Chir. Trans.* vol. xxv. p. 299.

⁴ Thus in Dr. Storch's case (*Journ. f. Kinderkrankheiten*, vol. xxxvii.), the seton was used with a fatal result. The dangers of setons in cases of cysts of the thyroid body are well known. They are perhaps less dangerous in other deep-seated tumours of the neck; but they should never be used without grave deliberation. I have seen the use of a seton in a case of this sort fatal in a week to a person otherwise in good health.

⁵ It was in all probability to such tumours as these that Mr. Liston refers in the following passage:—'In the lower triangular space of the neck, though not so frequently as in the upper one, all sorts of strange tumours are encountered. Many watery tumours are met with here—some of them in young patients, and congenital; others appearing at a later period. The smaller ones may be opened and dressed from the bottom, or treated with escharotics. Some of them may be punctured and treated by seton; others have besides a mass of solid material attached, and then extirpation, if practicable, is to be preferred. A curious case occurred in my hospital practice lately: a middle-aged healthy man applied on account of a soft elastic lobulated mass, filling completely the space above the right clavicle. It was taken to be a fatty tumour, and was cut upon accordingly. The first incision gave vent to an ounce or more of serum. The dissection was pursued, and six or eight other distinct sacs adherent to each other were gradually exposed and extracted. The space of the neck was completely laid bare, the nerves could be seen, and the subclavian artery pulsated at the bottom of the wound. The internal jugular vein, for two inches, was exposed; and, for the first time, I was cognisant of air rushing into a branch entering into the root of this vessel. So complete was the exposure of parts that the carotid and subclavian arteries could have been tied without further dissection. All went well.' Liston, *Practical Surgery*, 4th ed., p. 330.

⁶ *Archiv f. klin. Chir.* vol. i. part 1, *Beiträge zur chirurgischen Pathologie der Venen*, one of the most interesting and important treatises in the whole range of surgical literature.

⁷ The published instances of this disease before the date of Langenbeck's paper will be found in Gurlt, *op. cit.* chap. vi. cases 3, 5, 6, pp. 266, 267.

drawing the head strongly backwards and to the opposite side; and that they are, sometimes at any rate, movable from side to side, but not upwards and downwards. It must, however, be allowed that these signs are hardly sufficient to distinguish them from other cysts in all cases without a puncture. After having tried all the usual plans of treatment, and after having succeeded in curing one of these tumours by maintaining suppuration in it for a year and a half, Langenbeck has found such measures so uncertain and so tedious that he prefers extirpation with all its risks.

The most ordinary of all surgical affections of the neck is the *enlargement of the glands*, which is so very common in scrofulous persons, especially children. On this head reference is to be made to the essays on *DISEASES OF THE ABSORBENT SYSTEM* and on *SCROFULA*. But I would here call attention to a point of some practical importance, noticed by Prof. Miller.¹ He points out that scrofulous enlargement of these glands 'must be carefully distinguished from the syphilitic glandular affection, characterised by implication of the whole chain of lymphatics on both sides of the neck, along the anterior margin of the trapezius. . . . The glands affected [with syphilitic disease] are painless, about the size of hazel-nuts, indurated, and never suppurate. They become affected in this manner before any eruptions make their appearance, and continue sometimes long after any other constitutional symptoms.' He regards this condition as almost pathognomonic of constitutional syphilis. He also describes another form of glandular enlargement usually on one side of the neck, of a stony hardness, and generally involving the whole lymphatic chain. The hardness closely resembles scirrhus, but has no real connection with the cancerous cachexia. It is due to anæmia, and is sometimes conjoined with exophthalmic goitre.

Other glandular affections in the neck are occasionally met with, though less commonly than above. Thus, in the sixteenth vol. of the *Mémoires de l'Acad. Nat. de Médecine* is a paper by Larrey, jun., on a form of glandular enlargement from chronic inflammation, which he has often met with among the younger soldiers of the French army, and which he refers neither to syphilis, scrofula, nor local irritation (unless it be excited in some cases by stomatitis, the result of the abuse of tobacco), but rather to the moral and material depressing causes incident to the change from the civil to military life. An enlargement of the cervical glands similar to that occurring in other parts of the body may depend upon the condition known as lymphadenoma.

A peculiar form of enlargement of the cervical glands is described by Dr. J. W. Ogle in '*Path. Soc. Trans.*' vol. xi. p. 255, in which they formed a chain of large rounded tumours, which were successfully removed by operation. The nature of the affection remains obscure.

These glandular affections also may implicate the sheath of the great vessels of the neck. Thus in Larrey's case, mentioned below, p. 885, and in several of those referred to by Langenbeck, enlarged glands were found in the substance of the sheath itself; and on their removal, the carotid artery or the jugular vein, as the case might be, but more commonly the latter, was left cleanly dissected out, and quite deprived of all covering from its sheath. Langenbeck cautions his readers not to be deceived into relying too much on the mobility of such tumours as a certain mark of their superficial position, since this may really be only the movement of one part of the tumour on another, and the deeper parts of the mass may be lying on, or between, or even behind, the vessels. He does not on that account shrink from advising the removal of such tumours when other means fail; but it is plain how great the dangers and difficulties of the operation may prove. It should, therefore, never be performed unless the glands affected are limited in number, unless the symptoms of the disease are really productive of serious distress, and unless a very patient trial has been given to topical and general remedies; and the surgeon ought to enter on the operation with a full knowledge of the difficulties he may encounter, and the precautions which are to be taken to meet them.

Cancer, also, whether of the epithelial or other forms, may affect the deep parts of the neck and implicate the sheath of the vessels. It may be known by its occurring later in life than the previously-named affections; by its less defined outline; the strings or processes which often project from it; the pain which it produces; its tendency to spread towards the pharynx and larynx, thus producing dysphagia and dyspnœa; by the more extensive interference with the circulation which it causes, and in advanced cases by the enlargement of the glands below the tumour. The innocent tumours previously described, though they may compress the vessels, do not infiltrate them: but with these cancerous tumours the vessels and nerves may be absolutely incorporated. If, therefore, they are to be operated on, it should not be without the most careful and repeated examination.

The diagnosis of tumours at the root of the neck, in fact in all parts of the region, but particularly at the root, near the pleura, must be carefully made from the *abscesses* which are so frequent in this situation, and which have been spoken of in the essay on *ABSCESS*. Such abscesses do not fluctuate at first, in consequence of their deep position and their being bound down by the fascia; but they are seldom, if ever, found without some sign of inflammation, besides which the diseases on which they often depend will be present and will materially

¹ *System of Surgery*, 1864, p. £44.

assist diagnosis. These are scrofulous affections of the glands, disease of the vertebræ, inflammation of the pleura, and, it is said, disease of the arteries; other abscesses, however, having no visible exciting cause, are not uncommon. The rate of progress of the disease, its much more acute symptoms, and the ill-defined extent of the swelling, usually distinguish abscess from tumour. Hydatid cysts have also been found in this as in most other regions. Mr. Dixon's case is well known;¹ and others, both within the thyroid body and external to it, will be found in Gurlt's work. The proper treatment will be to lay open the cyst, take away all the hydatids, and allow the cavity to fill up by suppuration.

The *sterno-mastoid muscle* may be occasionally found indurated, and forming a sort of tumour, which extends up a great part or the whole of the neck. This affection has been already referred to in the essay on DISEASES OF MUSCLES, and I only mention it here with reference to diagnosis. It is most common in children. Indeed Mr. Bryant, in his 'Lectures on Surgical Diseases of Children' (p. 142), speaks of it as though it were peculiar to early life. I have seen cases in the out-patient room of the Hospital for Sick Children, in one at least of which I thought the affection was syphilitic; but in others no such taint has existed. It has been suggested that this condition may depend upon a rupture of some fibres of the muscle during a difficult labour. It must be carefully distinguished from an enlargement formed by strumous glands, and there will be no difficulty in doing so, if the surgeon will bear in mind the existence of the affection. The obvious test is that the swelling in one case is within the sterno-mastoid, and its mobility varies with the contracted and relaxed state of the muscle; while in the other case the swelling is behind the sterno-mastoid, and is unaffected by its action. The muscular affection is a very curable one in childhood, and very often perhaps would disappear spontaneously; if not, heat or gentle counter-irritation, with attention to the general health, will cure it; while the glandular affection, unless owning a well-marked local cause, is a very rebellious one, and may prove quite incurable.

Enlarged bursæ are found in the anterior part of the neck, although rarely. At least the cases of this disease which are on record are few; but this, as Gurlt observes,² may proceed from the triviality of the affection as probably as from its rarity. These bursæ may be situated either in front of the *pomum Adami*, between the posterior surface of the hyoid bone and the thyroid cartilage, or between the muscles of the tongue. The two former bursæ are found in the normal state, although that in front of the thyroid cartilage does not always exist. The bursa among the muscles of the tongue is an accidental formation, and has been spoken of in the essay on DISEASES OF THE TONGUE. The first kind (the anti-thyroid bursa) forms a rounded fluctuating superficial swelling in front of the larynx in the middle line, reaching downwards towards, and in a case recorded by Larrey³ even prolonged to, the sternum by a fistulous channel. The second (the supra-thyroid bursa) is of smaller size, and lies on one side of the middle line, covered by the thyro-hyoid muscle. Both of course follow the larynx in its movements during deglutition, and so far resemble the cysts of the thyroid body; from which, however, there can be but little practical difficulty in distinguishing them. If there be any doubt about the diagnosis, the character of the fluid evacuated by puncture will settle the point. Instead of the disintegrated remains of blood which are found in the thyroid cysts, these contain the jelly-like fluid which characterises bursal tumours and ganglions in other parts of the body. The treatment should be the same—viz. puncture and blisters, or injection of iodine.

A curious and rare affection in the neck is the *congenital fistula*, originally described by Dzondi and Ascherson,⁴ and of which I have given an account in another work.⁵ I need merely say here that these fistulæ communicate often with the trachea, and in some there has been reason to believe that a communication existed with the pharynx; that they form one or more minute openings, sometimes in the middle line, at others on both sides and at the same level, or again on one side only (generally the right); their position varying from the level of the notch which marks the upper border of the thyroid cartilage down to the neighbourhood of the sterno-clavicular joint. The only case I have seen was amenable to a very simple plastic operation, but here no communication with the trachea or pharynx could be traced. The inconvenience caused by the fistula is so slight that I should not recommend any more radical proceeding. The origin of these fistulæ is referred by Ascherson to the persistence of portions of three fissures which were discovered by Rathke to exist in the neck of the human embryo and those of other warm-blooded animals at an early period of development, analogous to the branchiæ of fishes, and coinciding in the time of their appearance with an arrangement of vessels similar to that which exists in fishes.⁶

Removal of tumours of the neck.—Tumours lying below the deep fascia of the neck are always a source of anxiety, and often of great embarrassment, in their removal; and this becomes more and more the case as the tumour passes further forward. When the mass lies

¹ *Med.-Chir. Trans.* vol. xxxiv.

² *Op. cit.* p. 39. A complete collection of the recorded cases of each variety of bursal tumour may be found here.

³ *Gaz. des Hôp.* 1853, pp. 212, 225.

⁴ Translated in Dr. Day's *Obstetric Records*, vol. i.

⁵ *Surgical Treatment of Children's Diseases*, 2nd ed. p. 158.

⁶ Compare also a paper by Sir James Paget, *Trans. of the Med.-Chir. Soc.* vol. lxi. p. 41, on 'Branchial Fistulæ in the External Ears.'

beneath the sterno-mastoid muscle, the surgeon must always consider carefully, before he commences the operation, whether he is likely to be able to bring it to a termination—that is to say, whether he has a fair prospect of removing the whole growth; for unless such a prospect exists, the operation is unjustifiable. The main points in these operations are so well detailed in an account by Mr. Spence of the removal of an enormous enchondroma from the neck and face, that I cannot do better than refer the reader to his most interesting paper in the 'Dublin Quarterly Journal of Medical Science,' Nov. 1863. The operation was, as far as I know, unique at the time, the tumour extending from the zygoma nearly to the clavicle, and from the spine to the cricoid cartilage, and weighing more than 7 lbs. In summing up the chief points of this very remarkable case, Mr. Spence dwells upon the following as the main considerations to decide the practicability of removing a tumour from beneath the sterno-mastoid muscle:—1. Is the growth innocent or malignant? If malignant, the important structures near which it lies will very probably be incorporated with it, and the tumour could perhaps only be removed by doing fatal damage to them; if innocent, however closely it may press on these structures, it will be enclosed in its own capsule, and by keeping the edge of the knife or scissors close upon the tumour, the main vessels and nerves will in all probability be avoided. 2. The state of the circulation; engorgement of the veins on either side,¹ or marked alteration of the arterial supply in the affected side, would give reason to fear that the growth is extensively connected with the internal jugular vein or the carotid artery respectively. And, finally, the impairment of the functions of respiration or deglutition, or the existence of laryngeal irritation, would point to implication of the vagus nerve, the phrenic or the laryngeal nerves, or to pressure on the œsophagus or air-tube. Careful exploration from the mouth, and an examination of the mobility of the tumour in various positions of the head, should not be neglected.

In the operation for removing such tumours, the main points are to have a very free access to the tumour, and for this purpose to dissect large flaps off it by crucial incisions, to define its surface clearly and for a large extent in some position where its relations are free from danger (usually its posterior border), and to work gradually from this point by stretching the tumour so as to make plain its cellular connections, and then cautiously dividing the latter with the scalpel or blunt-pointed scissors directed *towards* the tumour.² In Mr. Spence's case the extent of the growth was so great that the whole sterno-mastoid was of necessity divided; and then the plan which Mr. Spence adopted, of exposing the whole front of the tumour and cutting across the muscle at once, is no doubt the best, since it gives as full a view as possible of the whole neck, and enables the assistant (whose duties in these operations are almost as important as those of the operator) to compress the main vessels and to push them back, by insinuating his fingers in the track of the dissector. But in the case of a tumour situated beneath the sterno-mastoid of much less extent than in Mr. Spence's patient, although still of considerable size (since the dissection commenced above, over the mastoid process, and terminated below by exposing a part of the brachial plexus, and was continued backwards to the transverse processes of the cervical vertebrae), I was able to remove the tumour without cutting through the whole sterno-mastoid;³ and I believe that it is better to retain the sternal portion of the muscle entire, if possible, whenever the growth does not project beyond its anterior edge. This proceeding is more dangerous than that adopted by Mr. Spence, since the part of the growth lying near the carotid sheath has to be dug out, as it were, from beneath the muscle almost in the dark; but, on the other hand, the preservation of a part of the muscle is a safeguard against deformity. When the edge of the tumour has been fairly and cleanly exposed, the operator should next endeavour to clear its lower part, whenever there is a doubt as to its relations to the great vessels of the neck, in order to expose their sheath and render himself master of the circulation through them. Cases quoted below will show that both the common carotid artery and internal jugular vein may be tied without compromising the success of the operation; and even the division of the pneumo-gastric nerve also has been followed by recovery. But every possible effort should be made to remove the tumour without dividing any of these structures, particularly the last. The vein is the most likely to be implicated. Innocent tumours, even when they occupy the sheath of the artery, do not generally surround it. Langenbeck has shown that the jugular vein may be dissected out for some inches from the substance of a tumour, the vessel being entirely denuded and its whole sheath removed, yet no ill consequences follow.⁴ If the descendens noni nerve be in the way, as in Gibson's case, it may be divided. In the more delicate part of the dissection blunt-pointed scissors should be used, and the fingers should be employed to sever the adhesions of the tumour as much as possible,

¹ Langenbeck points out that in tumours which involve the sheath of the vessels engorgement of the veins of the face is rarely absent. In one case he observed this venous engorgement to be on the opposite side to the tumour. This he attributed to the fact that the tumour compressed the carotid artery as well as the jugular vein, as proved by the weakness of the pulse in the temporal artery.

² Dieffenbach (*Op. Chir.* vol. ii. pp. 327 *et seq.*) recommends, in operations on large tumours, to use two separate incisions, both longitudinal, one running over the front of the tumour, more or less parallel to the anterior edge of the sterno-mastoid, the other behind that muscle. He used to dissect the tumour free from its spinal attachments from the posterior incision, and to free it from the vessels, &c. by dissecting from the anterior one. His main object seems to have been to avoid the division of the sterno-mastoid; but a sufficient number of cases are now on record to prove that even the entire section of this muscle does not do any material harm.

³ *Lancet*, 1864, vol. i. p. 576.

⁴ *Archiv f. klin. Chir.* i. 4, 14.

and as a guide or director to the cutting instrument when the wound is too deep to allow of a clear sight of the parts. Compression of the internal jugular below the tumour will be a safeguard against death from the entrance of air into the heart.

Such operations as these appear to have been rarely undertaken,¹ Mr. Spence's researches having only discovered four published cases of the kind by British surgeons² previous to the publication of his own; but smaller tumours, mostly of an enchondromatous or solid fibrous nature, lying in the anterior triangle of the neck, or over the parotid gland, are very common, and the operations for their removal must be managed on the same general principles—viz. to open the capsule of the tumour (when it has one), expose its surface freely in some safe part, and then stretch and carefully sever the cellular adhesions of the other parts. In doing this the operator must take all possible precautions not to permit the entrance of air into the veins, and all large veins should be tied before they are cut.

Foreign surgeons have been somewhat more bold in their treatment of these formidable tumours. Langenbeck's brilliant operations have been referred to; and his paper should be studied by every surgeon entering on this department of operative practice. In connection with this question the reader may also be referred to the paper by Larrey in the 16th volume of the 'Memoirs of the French Academy of Medicine,' in which the propriety and the method of performing these operations is discussed at length. M. Larrey regards such operations as being the most uniformly successful in the whole range of surgical practice, if only the risks of the operation itself are got over without disaster.³ Several interesting cases are quoted; especially one in which his father, the first Baron Larrey, removed a mass of diseased glands from the anterior triangle, one of which was imbedded in the sheath of the vessels; and another case in which M. Labat successfully extirpated a tumour extending from the mastoid process to the clavicle, and lying altogether beneath the sterno-mastoid muscle, which was divided across in order to expose it. The carotid artery and internal jugular vein had to be tied, and the pneumo-gastric nerve divided.⁴

[See Table on next page.]

The Axilla.

There are a few particulars with reference to *abscess* in the axilla to which it may perhaps be worth while to give a little attention. Superficial abscesses, indeed, have no characters in this region to distinguish them from those of other parts of the body; but deep abscesses, *i.e.* those situated in the cavity of the axilla, internal to its walls, often constitute a grave malady. Cases are on record where such abscesses have burrowed beneath the muscular walls into the neck, the back, and even the thoracic cavity. Their causes are various. Some depend on simple sprains or contusions, or occur without visible cause; others on lymphatic inflammation; others on caries of the bones of the thorax or of the shoulder; or even, it is said, on empyema or vomica.⁵ The symptoms of the spontaneous abscess will usually be more acute than those of the symptomatic; but the only reliable diagnostic sign is a thorough examination by means of the probe, under chloroform if possible.

It is of great importance in acute abscess of the axilla to procure a ready and free escape for the pus; since if the opening is small, and the abscess is allowed to get into a chronic condition, it is very liable to fall into the condition of a sinus, which is then kept from healing by the action of the muscles. Therefore, if the abscess is seen before opening, a free and large incision should be made, care being taken to keep the edge of the knife towards the thorax, in order to avoid the large branches of the axillary vessels and nerves which lie towards the humerus. If the abscess be in a chronic condition, and no evidence of diseased bone be detected, the treatment is not easy. If the arm be kept at perfect rest, and the patient be well nourished and fattened, the abscess is most likely to fill up, but it will be at the risk of some loss of motion from cicatrization and adhesion. This seems, on the whole, the best course; for laying open the whole cavity may do more harm than it is meant to obviate. Sinuses must be treated in the usual manner by stimulating injections, setons, or drainage-tubes, with rest. If adhesions or cicatrices have formed, their subcutaneous division will be indicated; and

¹ Some surgeons are indeed formally opposed to such endeavours. Thus Professor Miller says that 'tumours beneath the sterno-mastoid do not admit of operative interference.' *A System of Surgery*, 1864, p. 846.

² Mr. Atkinson of York relates, in the *Med. and Phys. Journ.* vol. xxx. p. 353, a case, the physiognomy of which, as given in the drawing, is something like that of Mr. Spence; but the account is obscure, and it is not said whether the tumour lay above or below the sterno-mastoid. This tumour weighed 3 lbs. 9 ozs., and the carotid artery and jugular vein were exposed in its removal. The operation was successful. Mr. George Bell has also put on record, in the *Journal of Medical Sciences* (Edinburgh, vol. i. 1826, p. 61) an operation for the removal of a tumour weighing about 4 lbs. 'from the muscular fascia of the neck.' This tumour lay above the sterno-mastoid, but dipped down, so that the common carotid artery was exposed in removing it. It stretched from the mastoid process to the clavicle, and seems to have been of a malignant nature, as it recurred a few months afterwards.

³ Dieffenbach also says: 'Eine grosse Anzahl Operationen dieser Art, welche ich gemacht habe, sind in keinem einzigen Falle von einem tödtlichen Ausgange begleitet gewesen, und die Heilung erfolgte gewöhnlich ungemein rasch.' *Op. Chir.* ii. 322.

⁴ In Gibson's case (*Am. Jour. Med. Sc.* vol. xiii. p. 305) the tumour was successfully removed from the sterno-mastoid after the carotid artery and jugular vein had been tied and divided. The descendens noni nerve was cut, but the pneumo-gastric was dissected out of the mass. The disease was malignant and recurred; yet it was enveloped by a very firm and distinct capsule.

⁵ Nélaton, *Path. Chir.* vol. v. p. 875.

Table of the Chief Forms of Tumour in the Neck.

	Origin and progress	Relations to neighbouring parts	Morements communicated from neighbouring parts	Fluctuation	Remarks
Abscess.	Recent origin. Quick progress.	Soon affecting the skin.	No.	Yes.	Known by the inflammatory oedema of the skin, except when chronic. May often be known by its complete transparency. Fluid resembling blood, or variously blood-tinged, often evacuated on puncture, sometimes composed of small cysts containing clear fluid. A rare but very trivial affection; the diagnosis obvious in the few cases I have seen.
Abscess below the fascia.	do.	Sometimes rapidly producing great pressure on the pharynx.	No.	Possibly not perceptible.	
Simple hydrocele.	Sometimes congenital. Gradual growth.	Usually superficial; in some cases dis- places or lays round the sterno-mastoid.	No.	Yes.	
Compound cystic tumours.	Always congenital. Growth often rapid, but sometimes slow.	Spread variously, and often very extensively.	No.	In parts.	
Bursal tumours.	Remote origin and slow growth, generally.	Limited to the three situations pointed out on p. 885.	Moves with the larynx.	Yes.	Can often be made to share the pulsation of the carotid in proper positions of the head (v. p. 881). In strumous patients hard and indistinct, depending upon some local source of irritation; in syphilitic, hard and distinct (shotty), no local irritation; in lymphadenoma, soft and distinct, forming large tumours; in cancer, involving surrounding parts and connected obviously with some primary growth. They are known from enlarged glands by their softness and the absence of remote affections; from malignant tumours by their slow growth and by their limitation.
Simple sebaceous tumours.	Not congenital. Slow growth.	Superficial.	No.	Not usually, only when the fluid is thin and the cyst not tense.	
Deep sebaceous cysts.	As above.	Lying in the carotid triangle, pressing the great vessels, and perceptible from the mouth.	No.	Imperfect fluctuation may sometimes be felt from the mouth.	
Glandular tumours.	Connected with the development of other diseases. Growth variable; usually multiple.	Very various; generally forming a superficial chain down the neck.	No.	Only when suppurating.	
Other innocent tumours.	Non-congenital. Growth usually slow.	Very variable; seldom make pressure on the deep structures, unless of long growth, and never infiltrate them.	No.	No.	Known by their rapid diffusion and absence of distinct limitation, together with the usual symptoms of cancer; the cachexia often marked. Diagnosis generally quite easy. May pulsate, or be accompanied by protrusion of the eyeballs and heart-affection.
Cancerous tumours.	Not congenital. Growth usually rapid.	Liable to spread rapidly and deeply; enclosing the great vessels, and pressing on the trachea, pharynx, &c.	Occasionally; if it have become attached to the trachea.	No; or only in small portions.	
Enlargement of thyroid.	Often in females; originating about puberty or later in life. Growth generally slow and limited.	Lobulated swelling confined to the situation of the gland or one of its lobes; very seldom compressing the trachea, and hardly ever the great vessels.	Moves very freely with the action of deglutition.	Often contains large cysts.	
Induration of sterno-mastoid.	Always congenital. Slow, or no increase.	Limited to the course of the fibres of the muscle.	Shares the movements of the muscle.	No.	

should much skin have perished, it may be thought right to free the cicatrix from the sound skin in its whole extent, and cover it with a transplanted flap.

Tumours occupying the axillary space, like those developed in other situations where large loose areolar intervals exist, are liable to grow to a very large size before they produce so much distress as to oblige the patient to request relief from a surgeon. In examining such a tumour two main questions present themselves: first, whether it is innocent or malignant; second, whether, if innocent, its relations are such as to permit of its removal. It is true that even in the case of a tumour judged to be malignant, if it could be very clearly separated from the periosteum of the humerus, it might be proposed to excise it; but in most cases of cancer, amputation would be the preferable course, if any operation were admissible. Nothing need be said here about the diagnosis of innocent from malignant disease, this being the same in the axilla as in other parts. We pass on to the question of the relations of the tumour. Superficial tumours are decidedly rare in this region. Notwithstanding the hairy condition of the integument, sebaceous tumours are hardly ever met with. I do not remember to have ever seen one removed from the axilla. The tumours which lie below or in the fascia are of course less movable than those in the subcutaneous areolar tissue. If the mobility be extremely limited, this may be due either to their attachment to the bone, or to their being connected with the sheath of the vessels; the former tumours will be almost immovable, and there will probably be no interference with the circulation; the latter will enjoy somewhat more movement, and the circulation will be more or less impeded. If the venous congestion and oedema be well marked, while the pulse is unaffected, there is direct evidence of pressure on the vein; while if the pulse be also weakened, the tumour probably envelopes and compresses both vessels. Its relations to the nerves will generally be determined by the occurrence of twitching, 'pins and needles,' or numbness. Tumours adherent, even over a great extent, to the sheath of the axillary vessels, may be removed with success by a daring operator, as Langenbeck's experience shows; and even if it were necessary to tie both of the vessels, it would be better to run that risk than to sacrifice the arm; but when the nerves are also involved, the case becomes almost desperate, especially as the most important of the nerves—the median—will be in all probability the most deeply implicated.

Exostoses and other tumours springing from the upper end of the humerus may project into the axilla, and may come into more or less close relation with the vessels and nerves. Thus in the case of a lad under my care at St. George's Hospital, a large exostosis, lapping round a great part of the humerus, raised up the artery for a considerable extent. But there is little risk of injury to the main vessels in operating on these cases, since the muscles which separate the bone from the artery can hardly have been atrophied, unless the tumour has attained most unusual proportions. The greater danger is to the circumflex or musculospiral nerve, as the case may be. In my case the tumour was so extensive as to trench closely on the position of both of them; but as there were no symptoms of pressure on either, I felt confident that it might be removed without injury, as turned out to be the case. Softer tumours implicating the periosteum of the humerus are always to be looked on with suspicion, since many of them are malignant. But if any doubt exists on this point, the minor operation of excision of the tumour and head of the bone should, no doubt, be resorted to. Sir W. Fergusson, in his lectures at the College of Surgeons, gave two cases in contrast with each other strikingly illustrative of the advantages of the course recommended.¹ In one, which was under Mr. Syme's care, that surgeon removed the head of the humerus with the tumour in 1860. A year afterwards the disease recurred in the scapula; and in November 1862 the scapula and a portion of the clavicle were removed with perfect success, leaving the patient with a useful arm.² In the other case the arm had been amputated at the shoulder-joint before the patient came under Sir W. Fergusson's care, who was obliged, by the recurrence of the disease, to remove the scapula. A case under Mr. Hutchinson's care³ shows that, even in malignant tumour of the humerus, its removal by the operation of excision may be followed by the union of the wound, but does not give much encouragement for the practice, since the patient's life does not seem to have been prolonged by it. It is right, however, to add that the operation was performed by Mr. Hutchinson only after amputation had been refused by the patient.

The removal of *enlarged glands* from the axilla is generally a very simple matter when performed, as it usually is, as part of the operation for scirrhus of the breast; since the glands affected lie near the pectoral muscle, away from the large vessels. The extirpation of strumous glands is a measure of doubtful prudence;⁴ and yet if there is no other indication of the strumous cachexia, and the tumour is productive of much inconvenience, such operations are sometimes undertaken. I once performed such an operation on a child, and ascertained that the patient remained in good health and free from any other manifestation of struma for at least a year, after which time I lost sight of her. An operation of a similar kind is reported in the '*Lancet*,' 1850, vol. ii. p. 22, as having been performed by Sir W. Lawrence. But if the surgeon determine on this proceeding, he must not deceive himself as to its

¹ *Lectures on the Progress of Anatomy and Surgery*, pp. 46-49.

² Syme, *On Excision of the Scapula*, 1864, p. 22.

³ *Path. Soc. Trans.* vol. viii. p. 346.

⁴ See the essay on SCROFULA.

probable difficulties and dangers. In loose cellular spaces, as the axilla and the neck, besides the glands which are perceptible before the operation, there are sure to be others more deeply situated which are only perceived after the removal of the first. This has been the case in all such operations as I have witnessed. It was so in the instance referred to under Sir W. Lawrence's care, as well as in my own case, and in two such operations which I have witnessed in the neck. In my case the axillary artery was wounded—I believe inevitably. In one of the cases in the neck to which I refer a considerable mass of disease was left behind. In Sir W. Lawrence's case the difficulties and embarrassments seem to have been great, and would have been very disagreeable anywhere except in hospital practice, where plentiful resources and assistants are always at hand. Again, in most of these cases (as in three of the above four) the glands have been found to be in a state of suppuration; and it must remain doubtful whether nature would not have accomplished the removal of the strumous tubercle in this way as completely as the surgeon. Therefore such measures should only be resorted to after the most mature consideration; and everything should be at hand which is necessary for a prolonged and difficult dissection among large vessels and nerves.

Langenbeck, in the paper above referred (p. 881), has dwelt upon the frequency with which the tumours, glandular and others, developed in the axilla are found attached to the sheath of the large vessels, and on the best means for extirpating them. That innocent tumours may be removed with success, whatever be their size and however extensive their connections, is proved by the case related by Langenbeck,¹ in which he removed a portion of the clavicle affected by a tumour dipping deeply in between the jugular and subclavian veins, and affecting the scalenus anticus muscle, which had to be divided.

Table of the Chief Surgical Affections of the Axilla.

	Origin and progress	Fluctuation	Bruit	Pulsation	Accompanying symptoms
Enlarged glands.	In connection usually with disease of the parts from which the lymphatics come. Progress slow.	No.	No.	No.	When not associated with disease of the lymphatics, one of the usual constitutional affections will be present.
Abscess of glands.	Origin as above. Progress rapid, and skin soon implicated.	Yes.	No.	No.	
Subpectoral abscess.	Often from injury. Progress rapid.	Not always perceptible.	No.	No.	In cases of doubt an exploratory puncture clears up the diagnosis.
Cysts.	Origin remote. Progress slow, or none.	Yes.	No; or only a 'thud.'	No; or only communicated from the artery.	
Aneurism.	Originating often in accident. A defined tumour, growing more or less rapidly.	Variable.	Yes.	Yes.	The pulse in the affected and sound arm will probably differ.
Ruptured artery.	Originating in accident. An ill-defined swelling; often hardly increasing at all.	Probably.	Yes.	Very probably not, or very obscure.	See the observations on p. 84 of vol. iii.
Innocent tumours.	Origin remote. Progress slow.	No.	No.	No.	The various effects of pressure on the vessels or nerves may be present, and should be carefully noted before proceeding to remove the tumour.
Cancer.	Origin less remote. Progress rapid.	No.	No.	No.	The vessels and nerves are far more likely to be surrounded by the tumour, or even infiltrated with cancer.

Langenbeck recommends that the anterior surface of the tumour be freely exposed, the muscles being divided as far as may be necessary. In one of his successful cases, both pectoral muscles, the deltoid, and a portion of the coraco-brachialis were divided. The tumour is then to be exposed by a free division of its capsule, and the vessels are to be sought for above, where they enter into the tumour. This course he prefers to the opposite plan of exposing the artery and vein at the lower part, for similar reasons as in the neck (see p. 884). The sheath of the vessels, infiltrated by the disease, must be carefully divided and stripped from the vessels, which should only be tied in the last resort. If the great nerves be implicated in the tumour, so that they cannot be cleared away from it, amputation will become

¹ I mean with success so far that no fatal injury was done to the parts. The patient died of the after consequences of the operation.

necessary. I recommend a very careful study of Langenbeck's cases to any one who intends to perform one of these operations. A good idea of the probable relations of the tumour will be found by noticing the presence or absence of pricking sensations down the course of the nerves, or loss of their functions, of oedema and venous engorgement, and of alteration of the pulse. In cartilaginous or hard fibrous tumours, processes may project, deep in the axilla, among the vessels and nerves, or may run under the clavicle and approach the sub-clavian vessels and the pleura, and much add to the embarrassments and dangers of the proceeding. This is still more the case when the tumour originating in the neck has passed down into the axilla, as in Langenbeck's case, referred to above, in which the pleura seems to have been freely exposed, though not opened; and the patient afterwards died of pleurisy. However, in a case of a large fatty tumour of the root of the neck, which was under my care some years since, at the Hospital for Sick Children, and which sent a process down into the axilla, the removal was easily and safely effected from the main wound in the neck. A drainage-tube was passed through the cavity in the axilla, and out below the edge of the pectoralis major. The child recovered without any deformity or bad symptom.¹

In cases of tumours which implicate the axillary vessels, the vein is often the one which is most firmly attached to the tumour. This is a consequence partly of its position and partly of its being (like all veins) more readily affected by pressure. Consequently there is more risk of wounding the vein than the artery in such operations. In case of wound of the vein, the late Mr. Moore recommended that the artery should be secured as well as the wounded vein, and he used to refer to a case in which he had adopted this practice successfully. He believed, on the authority of this case, as well as of some of the others quoted above in which the main artery and vein have been tied in the removal of cervical and other tumours, that phlebitis is less likely to follow, and that the risk of gangrene is not increased by the ligation of the artery. I may add, that when in such operations the brachial plexus is also injured, the limb should be removed at once. I had occasion some time since to regret not having followed this course. In an attempt to extirpate an extensive recurrent cancer from the axilla, I was obliged to secure both vessels. The parts were very much matted, thickened, and difficult to distinguish. The patient died of gangrene, and on post-mortem examination a portion of the median nerve was found to have been embraced in one of the ligatures.

The Thorax.

The diseases of the thoracic viscera being the exclusive province of the physician, and their injuries having been treated of in our second volume, together with the surgical operations practised upon the pleura, no observations on the regional surgery of the thorax are required here, except a few lines on the subject of abscesses in the thoracic parietes. Such abscesses may arise spontaneously as the result of acute or chronic inflammation, or may be symptomatic of disease of the bones. Diffuse inflammation is the most common cause of the first kind of abscess. It is a serious affection, being often productive of much distress by its local action, as well as testifying to the existence of a grave constitutional malady. Nélaton² speaks of a case in which the dyspnoea was so great as to lead to the erroneous diagnosis of visceral inflammation; an error the more likely to be committed since the inflamed condition of the integuments forbids physical examination. Besides, visceral inflammation may ensue; for the inflammation tends to spread inwards, and if unchecked leads to the formation of abscesses which may extend beyond the walls of the thorax, and make their way into its interior. Active treatment is therefore necessary. If the case is seen before abscess is formed, free incisions must be made, and the other means adopted which have been prescribed in the essay on Erysipelas for the treatment of diffuse cellular inflammation. If abscess have already formed, it must be opened without delay. The constitutional treatment must be guided by the general symptoms, and by the presence or absence of pleuritic complication—a fact which can only be inferred from the symptoms, if the condition of the parietes forbids direct examination.

Chronic abscess of the chest, unconnected with disease of the bones, appears generally to take place in strumous subjects, and often in those who are suffering from or predisposed to phthisis. The treatment is the same as in other cases of strumous abscess. Many of those cases which are described in books as abscess pushing the pleura inwards, thickening it, and encroaching on the cavity of the chest, may very likely have been cases of limited empyema; at any rate they could hardly be distinguished from the latter except by the history, often an obscure guide in a chronic complaint. The treatment would consist in laying them open; and if this does not suffice, in providing a counter-opening, and keeping them empty by means of a drainage-tube. In some cases of empyema much benefit has seemed to be derived from a counter-opening, and the injection of iodine; and the same benefit might be more confidently expected in chronic abscess not connected with the pleural cavity, without the dangers which must be allowed to accompany the iodine injection in empyema.³ It is not, however, always easy to know whether a small opening may not exist into the pleura,

¹ *Surgical Treatment of Children's Diseases*, 2nd ed. p. 371.

² *Path. Chir.* vol. iii. p. 497.

³ In one case, at the Hospital for Sick Children, iodine injection had been used several times with benefit, when suddenly one day the child coughed up a quantity of the injection. This was followed by very severe bronchitis. The same accident happened to a child under my care at St. George's Hospital, but was not followed by any alarming symptoms.

or even the tissue of the lung. An open abscess, whose wall is in contact with the pleura, will follow its movements. Hence in inspiration its wall will be drawn inwards, and its cavity filled with air, which will be ejected in forced expiration.

Most abscesses, however, in the walls of the thorax are symptomatic of disease of the ribs or sternum. The disease is generally caries, though necrosis is sometimes met with; and in some cases, at any rate, it is clearly traced to an injury—usually fracture of the sternum, or separation of its first joint. Thus Nélaton (*loc. cit.*) quotes from J. L. Petit and from Stalpart Van der Weil cases in which after gunshot contusion, and after a sword-thrust, abscess formed on both surfaces (as it seems) of the sternum, and in which, after cutting down on the front of that bone, the surgeon perforated it with the trephine, and evacuated the matter from the anterior mediastinum. But what the indications for this proceeding were, the accounts appear too meagre to inform us. When, as is more usual, the abscess proceeds from caries of the rib, it appears better not to be too active. The partial resections of the ribs which are spoken of in foreign works on surgery, and which have been chiefly practised in Germany, do not seem very promising operations, while they are by no means free from difficulty and danger. The indications for attempting the removal of a portion of carious rib would be if it were evidently setting up pleuritic irritation, or if it concealed and shielded a sequestrum on the inside of the bone, which could not otherwise be extracted. In accident, the indications for excision are—if the fractured portion conceals a wounded vessel or traumatic aneurism. If the whole depth of the bone be not diseased, the surgeon would of course desire to avoid wounding the intercostal artery, the bleeding from which is often troublesome. In such cases it would be sufficient to detach the muscles from the upper border of the bone, and carefully chisel away the diseased portion. But if the entire thickness of the bone is to be removed, a small incision must first be carefully made through the muscular parietes, and extended on the director as far as may be necessary to separate the muscles from both edges of the rib to the whole length which it is proposed to remove. Then the internal surface of the bone must be freed from the pleura with the handle of the knife, or some more appropriate flat smooth instrument, and the section made with a Hey's saw.¹

Nélaton describes, after Boyer, an operation for the removal of diseased parts of the sternum, in order to evacuate matter confined in the mediastinum, and to remove the source of such suppuration. This has the distinction of being one of the most ancient surgical operations, and was performed by Galen. If a surgeon had made up his mind to make trial of the operation, he would need no very precise directions for its performance; as it consists merely in exposing very freely the surface of the bone, and applying the trephine on all the part which appears diseased; but it seems a doubtful and very hazardous measure, and could only be justified by the presence of severe dyspnoea, for which no cause, except the disease of the sternum, could be discovered. In Heyfelder's work (p. 308) will be found a notice of twelve cases in which this operation had been performed in modern times, and only one of which is said to have died from the operation. But real evidence of success seems wanting in the majority of these cases.

The Abdomen.

Very little of importance has been left for our consideration in this place as to the regional surgery of the abdomen, except abdominal tumours, since its injuries and the surgical diseases of all the viscera—digestive, urinary, and generative—have been described in separate essays. The first consideration in determining on the surgical treatment of a tumour of the abdomen is whether it lies superficial to or beneath the muscular expansion. It is possible that tumours may also form between the muscles, but the circumstance does not seem to have been put on record. Superficial tumours of the abdomen are usually fatty. Their superficial situation is recognised by the ease with which they move on the deeper parts, and by their being unaffected by the action of the muscles; the usual dimpling of the skin when pinched up over them, and their lobulated exterior, proves their fatty nature. The only caution which can be required in their removal is to remember that occasionally fatty tumours in the middle line of the abdomen have been found to perforate the abdominal parietes; and, although apparently superficial, to spring from a root in the subperitoneal fat. Such tumours are called by French writers '*hernies graisseuses*.'² Their connection with the peritonæum varies in different cases. The greater part, and usually the whole, of the tumour is formed by the subperitoneal fat merely; but in some cases a small process of peritonæum has been found in the centre of the mass, having apparently been pulled down by the traction of the tumour. At other times cysts have been found in the fat, unconnected with the peritonæum. Usually these small tumours require no treatment; but several cases are recorded in which symptoms of colic or of peritonitis have existed, which have been thought to have depended on the traction of the tumour, and which at least have subsided on the removal of the latter. When such symptoms are present, there would often be a good deal of difficulty in distinguishing the case from one of strangulated hernia. In cases of doubt, it is justifiable to cut down and examine the swelling, taking care to unroll the mass of fat before cutting it away, for fear of wounding one of these peritoneal pouches; but M. Nélaton gives the caution not to be in too great a hurry to operate on

¹ As to the statistics of this operation, Heyfelder says that out of thirty-seven cases of which he has accurate accounts, eight died; the rest recovered, and very speedily too. *Operationslehre und Statistik der Resectionen*, 1861, p. 303.

² Nélaton, *Path. Chir.* vol. iv. p. 394.

these tumours; and this advice coincides with that given by Mr. Birkett in the essay on HERNIA in all cases of umbilical hernia, where the symptoms do not very plainly indicate strangulation.

Other superficial tumours, whether innocent or malignant, differ in no respect in this region from their usual characters in other parts of the body. A word of caution may be given as to diagnosis. Most surgeons must have seen psoas abscesses mistaken for tumours of the abdomen—a mistake not very creditable to the care of the person who makes it, since it shows that he has neglected to inquire into the history and symptoms of the case; but easy enough to commit on a mere cursory inspection of the part.

The deep tumours of the abdomen, which lie beneath the muscles, are next to be distinguished into loose tumours, tumours of the bones, and tumours of the viscera or peritonæum. Of the loose tumours, some lie in the subperitoneal cellular tissue. Among these I would especially call attention to a tumour of the iliac fossa described by M. Nélaton,¹ and of which an instance occurred under my own care.² It is a firm rounded tumour lying in the venter of the ilium, moving with tolerable freedom under the muscular wall of the belly, and with a stalk which can be distinctly traced to the inner surface of the ilium, near the anterior superior spine. M. Nélaton has seen more than fifteen cases; and it is a singular circumstance that all his patients were women who had borne children. This was so in my case also. He had operated twice with success, although in one instance he had been unable to avoid opening the peritoneal cavity. The tumour is of the fibrous or fibroid variety, and certainly bears to the naked eye a strong resemblance to the recurrent fibroid; but it did not recur in either of M. Nélaton's cases, and in mine for more than a year, during which I saw the patient from time to time, there was no sign of renewed growth. In removing such tumours great care must be taken to avoid the peritonæum, if possible; and it is well to be contented with as small an incision as will suffice to expose the whole tumour; since ventral hernia will most likely ensue, and the patient's comfort demands that the hernia should be as small as possible.

The singular peculiarities of this tumour in having always a pedicle from the crest of the ilium, and in occurring always in the same form, and always, as far as present experience goes, in women who have had children, appeared to deserve a special notice for it; but fibrous and other tumours may of course be found in other parts of the subperitoneal space. To all such tumours the same observation will apply, that the surgeon should wait awhile and be in no hurry to extirpate them, unless the fact of steady growth is well ascertained; and that in doing so he must take every precaution both to avoid danger from a wound of the peritonæum, if possible, and to guard himself from undeserved blame, should the tumour adhere so firmly to the membrane that its avoidance is impossible.

Malignant tumours, forming below the abdominal wall, will soon become fixed, from implication either of the viscera or the muscles; and thus the diagnosis will in all probability be correctly made during the interval of expectation above recommended in the treatment of deep-seated tumours which appear innocent.

Tumours which enjoy a wide range of motion are met with now and then in the abdomen, and are believed to be in many cases floating kidneys; but many of these tumours have had a range of motion far beyond what the kidney can possibly obtain.³ In such a case as I once heard of from a friend, where a lump in the belly could be moved from a little below the liver in a curved direction down into the iliac fossa and thence over towards the middle line, always maintaining the same limits, the loose body must have been either a foreign substance in the intestines, which was unlikely in that case from the direction and range of its motion, or more probably one of those concretions in the peritoneal sac so well described by Dr. J. W. Ogle and others.⁴ The limits to the range of motion of such a substance might easily have been fixed by accidental adhesions. The point is one of not much practical importance, since in hardly any circumstances would the idea of cutting down on such a substance be entertained; yet if it seemed to be setting up peritoneal irritation, such a proceeding might not be wholly unjustifiable.

The tumours of the bones are generally malignant, though enchondromatous and other innocent formations may occur. They are found in the iliac fossa, or in the pelvis, by examination from the rectum or vagina, or lying on the spinal column. They are recognised by their fixed condition, and the broad base which always connects them to the bone. They frequently compress, and often implicate, the great veins, giving rise to cedema and venous

¹ *Gaz. des Hôp.* Feb. 18, 1862.

² *Path. Soc. Trans.* vol. xv. In the operation the peritonæum was not opened, and the patient recovered.

³ Rokitsansky says, 'The occasional movability of the kidney is owing to insufficient fixation by means of the adipose fascia, and apparently also to an elongation of the vessels; we sometimes find that the kidneys can be moved from one to two inches along the spinal column.' '*Path. Trans.* vol. ii. p. 188, *Syd. Soc. Trans.*

⁴ *Path. Soc. Trans.* vol. vi. pp. 204, 208. Vol. viii. p. 212; in this case the loose body was larger than a billiard-ball. Vol. xii. p. 89; here the loose body was felt in a hernial sac before operation. Other specimens will be found described in the same Transactions.

congestion in the parts below. Some of the more malignant of these tumours pulsate, and thus simulate aneurism. The diagnosis has been spoken of in the essay on ANEURISM. The tumours which affect the spine, if they are large enough to be perceptible externally and to give rise to symptoms, are almost always malignant, and may sometimes be distinguished also by examination from the loins. The small exostoses, so common in old age on the front of the column, do not usually give rise to symptoms, and could hardly be felt from the outside of the body. None of this class of tumours is susceptible of treatment.

Tumours of the viscera of the abdomen constitute such a very large class, and are so very complicated in their diagnostic signs, that no sufficient exposition of the subject can be attempted here. They affect the liver, the omentum, the spleen, kidney, or intestine, the general surface of the peritonæum, the bladder; and in the female the uterus, ovary, or broad ligament. Nothing need be said here about the tumours of the intestines, or of the female generative organs, or of the urinary organs, since these have been treated of in the essays on those subjects.

Tumours of the liver are recognised by their position, by their comparative immobility, and by their being situated in an area beyond which the liver can be recognised as extending (either by touch or percussion), or at least by the liver's dullness extending quite up to them; and when situated on the edge of the organ by their raising the false ribs. Such tumours as are merely attached to the liver¹ will be more movable; but it would be difficult during life to recognise these as hepatic.

The tumours of the liver met with in surgical practice are either cystic or malignant. Sir B. Brodie has described, in his *Lectures on Pathology and Surgery*, some cases of watery cyst of the liver, in which no proof was given of the presence of hydatid animalcules, and in which a cure was effected by simple puncture with a trocar; in two cases without any symptoms, in another after severe inflammation, and the bursting of an abscess into the intestine, followed by the discharge of a membranous bag, which, however, Sir B. Brodie did not regard as a hydatid.²

Large hydatid cysts are accompanied by considerable enlargement, the tumour being rounded and smooth, fluctuating, but less distinctly than the watery cyst, and with a peculiar vibration, due to the presence of the semi-solid bags in the fluid.³ The smaller hydatid tumours, which are not perceptible externally, will not give rise to any symptoms. After some time ulceration may be expected to take place, by which the hydatids are transferred to some of the neighbouring viscera, or the sac suppurates and an abscess forms, which may burst internally or externally. In the latter event, the patient may survive; the others are almost inevitably fatal. Space would fail us to pursue the history of the disease if left to itself; our only object here is with its diagnosis and surgical treatment. The diagnosis of hydatid cysts is to be made from (1) an enlarged gall-bladder, (2) abscess, and (3) cancer. Other ambiguities may occur; e.g. when the cyst rises into the thorax it may be confounded with or the cause of pleuritic effusion; when it lies in the central part of the abdomen, with aortic aneurism, and other similar difficulties may be met with, but these are rare. It will suffice here to point out the ordinary diagnostic signs. In the first place, then, hydatids grow without any feverish or hepatic symptoms, which is a strong point in their diagnosis from abscess of the liver, and from enlarged gall-bladder. Otherwise the resemblance of some hydatid cysts to an enlarged gall-bladder is very striking; and it would be almost impossible to tell the difference by manual examination merely, as a reference to Frerich's plate, mentioned in the note, will show. Next, the smooth round surface of the hydatid swelling usually distinguishes it from the more lobulated mass formed by a large cancer of the liver; and, lastly, the fluctuation and vibration of a hydatid tumour are in some cases to be clearly and easily distinguished from the semi-solid feeling of cancer. But it must be allowed that, in very soft cancers with smooth surface, if constitutional symptoms be absent, as they often are in rapidly-growing medullary cancers, the diagnosis can hardly be made without an exploratory puncture, which should in such a case always be employed.⁴ I have seen cases in which the disease could not possibly be diagnosed without it.

When by puncture fluid (whether purulent or limpid) is discovered superficially situated in the liver, the question occurs whether it is right to open the collection, and if so, how? In case of abscess it would be advisable to open the collection as soon as practicable; and the safest way is by means of caustic. In the case of a hydatid tumour, it seems better to wait until the fact of growth is decidedly established; since such tumours sometimes remain long stationary, and the operation is a dangerous one. But if the cyst be increasing in size, and if it be superficial, the risk of leaving it alone becomes probably greater than

¹ As the hydatid tumour figured in Frerichs on 'Diseases of the Liver,' vol. ii. p. 242, *New Sydenham Society's Trans.*

² The occurrence of simple cysts in the liver, and the frequent co-existence of that condition with cystic degeneration of the kidneys, is illustrated in papers by Dr. Bristowe and Dr. Wilks in *Path. Soc. Trans.* vol. vii. and x.

³ This sensation is not always perceptible. Davaine recommends that in order to feel it, three extended fingers be applied to the most prominent part of the tumour, and that percussion be made with the middle one. Frerichs, *op. cit.* p. 242.

⁴ It is a measure, however, not absolutely devoid of danger. Frerichs (*op. cit.* p. 251) gives a case where death was caused by tapping a hydatid cyst and drawing off some of its contents with an exploring trocar.

that of operating. Several plans are in use. The one which was till lately, I think, the most common in English practice, is to make an opening into the sac with *potassa fusa*; other plans are to cut down on to the peritonæum, have the wound stuffed with charpie in order to excite adhesions, and then, after a few days, prolong the incision into the cyst; or simply to puncture and evacuate the tumour, as was done by Sir B. Brodie; or to keep the puncture open, and establish a sinus, through which the sac is washed out with warm water, diluted alcohol, solution of iodine, or even bile. Iodine is the fluid which has been generally used; but Frerichs seems to speak favourably of the use of bile as causing less pain, and correcting the putridity of the contents of the sac.

In a very interesting paper published in the 'Med. Chir. Trans.' vol. xlix., Dr. John Harley has related a case in which he effected the cure of a large hydatid tumour of the liver (the largest on record in which operation has been practised) by puncturing the sac above the umbilicus with a large trocar and cannula, tying in the latter till it lay loose in the wound it had caused; the cannula being kept free from obstruction by a catheter passed through it from time to time, and then supplying its place by two or three elastic catheters, the size of which was gradually increased until three or more of the size of No. 12 could be readily introduced. Iodine was freely injected through these catheters from time to time, and to prevent decomposition the sac was freely washed out with creasote water, of which on one occasion more than a gallon was passed through the sac, being injected through one of the catheters and running out by the others. Severe symptoms occurred during the treatment from hæmorrhage and discharge of bile into the sac. These were combated by strict attention to bandaging, and by the use of injections of sulphate of zinc and nitrate of silver. Dr. Harley appends to his paper a synoptical table of the published cases in which operative measures have been employed, to show the superiority of a free puncture of the sac, and its careful evacuation, over those plans of treatment in which the latter point is not secured. He rejects the method of opening the sac by means of caustic potash, as being much more painful and tedious than that by the large trocar, while it is not in his opinion at all safer. The point on which he lays especial stress is the necessity of providing free exit for the cyst-membranes, and a constant discharge for the fluid, which if retained will putrefy and poison the blood.

If there be much redness, and the fluid seem very near the surface, it may be thought justifiable to open the tumour by a simple incision; but it is dangerous, as the least escape of cyst-fluid into the peritonæum may set up fatal inflammation. If by palpation or on puncture the cyst is found to have undergone calcareous degeneration, as is not uncommon, no operative interference is justifiable.

Tumours connected with the spleen and the omentum less frequently come under the surgeon's notice, since they are not the subjects of surgical treatment. The former are chiefly known by their situation, and by their raising the false ribs on the left side, as hepatic tumours often do on the right. Cystic or other tumours in the omentum appear more pedunculated than visceral tumours, and give rise to few symptoms when solitary; but the colloid and other soft formations usual in this part are often merely part of a general affection of the whole peritoneal surface, leading rapidly to death.

It is certainly theoretically possible that some of these looser tumours within the abdomen should be made amenable to surgical operations analogous to those on ovarian cysts; but practically it will be very difficult to find a case in which there shall be at the same time sufficiently urgent symptoms, and yet sufficient evidence of constitutional immunity, to justify a surgeon in exposing his patient to the incalculable risks of such an operation.¹

The Groin.

The fold of the groin is one of the most fertile regions for the materials of surgical diagnosis; but most of these materials have been already treated of. Thus, in the essays on *HERNIA* and on the *DISEASES OF THE MALE ORGANS*, all the difficult and complicated questions of diagnosis connected with hernia, retained testicle, cysts of the spermatic cord, and all the varieties of hydrocele, have been studied, and the diagnosis of psoas abscess has been laid down in that on *DISEASE OF THE SPINE*. Artificial anus, again, as well as iliac abscess, and the abscesses forming round the caput cæci, have been spoken of in the essay on *DISEASES OF THE INTESTINES*. The affections of the skin of the groin, among which intertrigo is very common, will be found described in *DISEASES OF THE SKIN* and *ERYSIPELAS*. The chief points which remain for notice are the affections of the lymphatic glands, and the rare instances of bursal tumours and cysts unconnected with the testis or cord. The tumour formed by an enlarged gland may often be confounded with a hernia; but on this point it is only necessary to refer to the essay on *HERNIA*. The mobility of the glands distinguishes all except that which lies in the femoral canal. In such cases the regions from which the inguinal glands derive their absorbents—viz. the lower limb (especially the toes), the wall of the abdomen, the nates, anus, and genitals—must be carefully examined, for the disease in the groin is but a

¹ The cases which have occurred since the statement in the text was written of removal of the spleen by Mr. Bryant, M. Kæberle, and others, appear to me amply to justify it (see the *Biennial Retrospect of the New Syd. Soc.* for 1867-8, p. 220), although it is true that the spleen has been successfully removed in the human subject by M. Péan, and perhaps by other operators, as a reference to the same publication will show. The cases which have occurred hitherto have been summarised by Mr. Collyer in the *Lancet*, 1882, vol.

symptom. The after consequences of abscesses forming in these glands are often formidable, since they lead to ulcers with callous edges, in which often the enlarged and diseased gland is to be seen, or to sinuses which are often very intractable. In the first place, the remains of the gland should be extirpated with the knife, or destroyed by some caustic; the latter being perhaps the best plan, as these glands have little sensibility. If this does not suffice, the hard edges are to be destroyed with *potassa fusa*; or, as a last resort, chloroform is to be administered, and all the sinuses laid open to their very bottom by free and extensive incisions, the hardened edges being at the same time pared away. The wound must then be dressed from the bottom, the patient kept at rest, and liberal diet given, if the stomach will bear it.

Cysts are sometimes found in the fold of the groin, which are formed in the bursa lying near the hip-joint, under the tendon of the *psoas* muscle. If this bursa communicates, as it often does, with the hip-joint, the fluid will pass into the synovial cavity on pressure, and the tumour disappear on the limb being relaxed. If the bursa is separate, the rounded tumour will be irreducible. The diagnosis will be made from a consideration of these circumstances, and from the position of the small rounded tumour. The treatment will be that laid down in the essay on DISEASES OF THE MUSCULAR SYSTEM, vol. ii. p. 177 *et. seq.* More liable to lead to error are those cysts and those abscesses which lie in close proximity to the femoral artery and receive pulsation from it. It is, however, sufficient to be aware of the occurrence (however rarely) of such diseases, and of the general rules for the diagnosis of aneurism (as laid down in the essay on that subject), to avoid such a catastrophe as to mistake an aneurism for a cyst or abscess. But much caution ought to be used, remembering that sad mistakes have been committed on the subject.

Cysts of many other kinds may form in the groin—sebaceous, serous, sanguineous. Of these the sebaceous would differ in no respect from the ordinary disease as it takes place in other parts. The serous and other cysts are difficult of exact diagnosis without an operation; which should, however, be omitted until symptoms call for it. I have seen a blood-cyst dissected away from the sheath of the vessels in this part with good results. The patient was a young woman under Mr. Hewett's care.¹

Connected with the surgery of the groin a curious and rare affection ought to be noticed, which is denominated by the German surgeons the 'rider's-bone,' and is attributed to ossification of the tendon of the adductor longus or magnus muscle as a consequence of injury; such as is not uncommon in riding, while endeavouring to maintain the grip of the saddle. The following case, which I quote by Mr. Birkett's permission from a paper written by him,² will best illustrate the subject:—

A gentleman, 56 years of age, was, in early manhood, much used to riding on horseback, and regularly hunted three days a week at the least, being always well up to the hounds. He has always enjoyed robust health, and is very muscular. Twenty-five years since, when riding in a steeple-chase, at about the age of thirty, in the act of charging a fence, his horse, refusing the leap, swerved, and he felt something give way 'snap' in the upper and inner region of the right thigh. Immediately after he felt he had not his accustomed powerful 'grip' of the saddle. In the evening, even so soon after the accident, the thigh was swollen and bruised. It should be stated that he was neither thrown from his horse nor displaced in the saddle. The muscles of the right thigh were very weak for some months afterwards; indeed, the adductors have never regained their wonted power. Both Aston Key and Liston were consulted, and stated that they had never met with a like case. For at that time there existed a bony hardness in the course of the tendon of the adductor longus.

At this time there is a large exostosis in the region of the right spine of the pubes, which extends along its horizontal ramus, and seems to envelop the pubic attachment of the adductor longus muscle. The tendon of this muscle is converted into bone at its root, and, extending for three inches downwards in its substance, a conical piece of bone is clearly perceptible. The apex of this is pointed, and rounded off at its tip, as if cartilaginous. In the tendon of the left adductor longus there exists a similar bony deposit about two inches long, but no exostosis on the pubes. The other adductors are unaffected on both sides.

Prof. Billroth has described an ossification in the tendon of the adductor magnus, which he found in an after-death examination of an old cavalry man. It extended in that muscle for half an inch below its attachment to the pelvic bones.³

Prof. Longmore, of Netley, informs me that he has seen the 'rider's-bone,' but extremely rarely.

A similar local ossification of the soft parts, due to pressure and irritation, is stated to occur in the left arm of the Prussian soldiers, and is termed 'exercise-bone.'⁴

Finally, it may be advisable to call attention to the occasional occurrence of disastrous or even fatal hæmorrhage from the spread of phagedænic, strumous, or cancerous ulcers in the groin. The diagnosis of these forms of ulcer presents no difficulty in the groin beyond what it does in other parts; but this peculiarity in the relations of the femoral artery should make us more than ordinarily anxious to stop the spread of specific ulceration in the groin. Powerful caustics, such as *potassa fusa* or nitric acid, are the only local measures which can be trusted to arrest such of these ulcers as allow of treatment. The more active forms of cancerous ulceration are, of course, hopeless.

¹ *Path. Soc. Trans.* vol. ix. p. 383.

⁵ *Deutsche Klinik*, 1855, No. 27.

² *Guy's Hospital Reports*, 1868.

⁴ Virchow, R., *Die krankhaften Geschwülste*, vol. ii. p. 72.

Table of the Chief Surgical Affections of the Groin.

	Reducible	Fluctuation	External inflammation	Impulse on coughing	Re-sonance on percussion	Other chief symptoms
Abscess, psoas.	Partly.	Yes.	No.	Frequently	None.	Evidence of diseased spine. Swelling in iliac fossa.
„ glandular.	No.	Yes.	Yes.	No.	No.	Probably other inflamed glands, and some disease in the parts from which the absorbents come.
Abscess from diseased hip.	No.	Yes.	Varies.	No.	No.	Pain, involuntary resistance, or grating on passive motion of joint.
Abscess, simple.	No.	Yes.	Yes.	No.	No.	Resilience of fluid in a limited cavity. Inflammation of neighbouring skin.
Enlarged glands.	No.	No.	Varies.	No.	No.	Wound or other cause of irritation in parts from which the lymphatics come.
Cysts.	No.	Yes.	No.	Very seldom.	No.	Resilience of fluid in limited cavity. No surrounding inflammation.
Encysted hydrocele.	Partly, sometimes.	Hardly perceptible	No.	No.	No.	Resilience and absence of inflammation as above, with transparency. The cord running into the tumour.
Hernia, common.	Yes.	No.	No.	Yes.	If large.	Disappears occasionally, spontaneously, or on taxis.
„ incarcerated.	No.	No.	No.	Yes.	If large.	Similar history at one time. Has since become irreducible.
„ strangulated.	No.	No.	No, except when long unrelieved.	Not usually	Occasionally.	The sickness, constipation, umbilical pain, and other severe symptoms attendant on strangulation.
Retained testis.	Partly.	No.	No.	Sometimes, but obscure	No.	Absence of testis from that side of the scrotum.
Varix of saphena vein.	Yes.	Yes.	No.	Yes (accompanied by a thrill).	No.	Increased by pressure above; emptied when the circulation is stopped in the vein below.
Aneurism.	No.	Variable.	Seldom.	No.	No.	Pulsation and bruit in most cases; affection of the pulse in the trunk below.
Malignant disease.	No.	No.	No.	No.	No.	Infiltration of parts around with cancer; perhaps enlarged glands and cachexia.
Other tumours.	No.	No.	No.	Seldom.	No.	Gradual increase of the swelling, with absence of all the above and all other special symptoms.

The Popliteal Space.

The popliteal space is to be regarded, from a surgical point of view, as a large loose areolar interval in which the great vessels and nerves pass behind the knee-joint, and whose size and the laxity of its tissues allow them to move freely out of the way of the ends of the bones in forced flexion and extension. The glands which lie in this areolar tissue, the tendons and the bursæ in relation with them, must engage the attention of the surgical anatomist as well as the vessels and nerves. It is unnecessary for us here to go over the familiar points, which may be found in any treatise on descriptive anatomy; but it may perhaps serve a useful purpose to give an account of the usual arrangement of the bursal sacs which are in connection with the tendons.

In the 'Archives générales de Médecine,' 1856, sér. v. tom. viii. pp. 313, 426, M. Foucher has written an elaborate memoir on the tumour produced by enlarged bursæ in the ham, which will well repay perusal. M. Foucher there gives a description of the usual arrangement of the bursæ, which my dissections (though less numerous than M. Foucher's) enable me to confirm. There are found, according to this author, on the inner side of the ham, two bursæ—one between the inner head of the gastrocnemius and the femur, which sends a prolongation also between the gastrocnemius and the semi-membranosus, and is in close contact with the ligament of Winslow. This bursa very often communicates with the joint,¹ especially if it is enlarged. The second bursa, at the inner side of the space, lies between the tendon of the semi-membranosus and its insertion into the head of the tibia. It is of smaller size

¹ M. Foucher says, almost always in adults and old persons; a point which I regard as very doubtful.

than the preceding, with which it is in contact above, and sometimes in communication. In such a case this bursa may communicate with the joint, but not otherwise. Besides these, I have found, but only once out of nine dissections, a small bursa between the tendons of the semi-membranosus and semi-tendinosus, which is probably an accidental formation. On the outer side of the space a separate bursa is sometimes found under the outer head of the gastrocnemius, but more frequently merely a prolongation of the synovial membrane. There is also usually a pouch of the synovial membrane of the joint, between the front surface of the tendon of the popliteus muscle and the posterior ligament. This pouch may be replaced by a separate bursa. On the opposite (back) surface of the tendon, between it and the external lateral ligament, lying close to the peroneal nerve, there is usually a separate bursa. A bursa also occurs between the tendon of the biceps and the external lateral ligament, which is sometimes found distended with fluid.

Besides these regular and natural structures, which can always be recognised by dissection, there are also found other closed sacs, which appear to be diseased products. Thus M. Foucher notices that, in dissecting the popliteal space, he has occasionally met with cysts having no communication with the joint, and not situated in the position of the tendinous bursæ. These cysts he believes to be in most cases dilated synovial follicles: ¹ although he admits the possibility that some of them may be formed by a hernial protrusion of the synovial membrane through an opening in the ligamentous capsule, which afterwards becomes obliterated. ² Other cysts are found, though rarely in the cellular interspaces, which appear to be simply accumulations of fluid in the meshes of the areolar tissue, which have become enclosed in a capsule. If we follow this division, we shall have four classes of cysts in the popliteal space.

1. Bursal cysts, or dilatations of the above-mentioned bursæ of the tendons.
2. Follicular cysts, or dilatations of the synoviparous follicles.
3. Synovial cysts, or cysts formed by hernial protrusions of the synovial membrane.
4. Free serous cysts, or accidental cysts.

It must, however, I think, be allowed that the second and third classes have not yet been proved to be anatomically distinct from each other.

The first question which occurs in examining a rounded tumour in the popliteal space is, whether it is an aneurism, an abscess, an enlarged gland, a solid tumour, or a cyst. There is usually very little difficulty in establishing the diagnosis of the latter form of disease—in fact, when the cyst projects from the outer or inner aspect of the limb, there can be hardly any ambiguity in the matter. This is the case in the great majority of instances; those cysts being, as far as I have seen, the most common which are formed by the expansion of the bursa lying between the femur and the inner head of the gastrocnemius with the semi-membranosus muscle. But when the cyst presents, as it occasionally does, in the centre of the space close upon the popliteal artery, it may very closely simulate an aneurism at first sight. The diagnosis depends upon these particulars:—1. The cyst, though it contains thin fluid, is not altered in size by compression applied while the circulation in the artery is arrested; the aneurismal tumour is emptied partly or entirely under similar treatment, while it contains fluid. 2. The sound communicated to the ear applied over the tumour is never of the same prolonged blowing character with that usually heard in aneurism. 3. The pulsation communicated to these cysts is never of the expanding character of the pulsation observed in an aneurism with fluid contents. 4. Most of these cysts can, in some position or other of the limb, be dragged away from the artery, and the pulsation in the tumour then ceases entirely, though that in the artery continues unaffected, which is never the case in aneurism. 5. To these diagnostic marks Mr. Hart, in reporting a case mistaken for aneurism, ³ has added that in rigid extension of the limb the pulsation of the cyst almost disappeared. Finally, if, after a very attentive examination, the surgeon cannot yet make up his mind, it will be justifiable to clear up the doubt by inserting a grooved needle; but this measure will be hardly ever resorted to after a sufficient examination in any case which afterwards proves to be an aneurism.

It is impossible sometimes to diagnose the nature and connections of blood-cysts before dissection. Of this the following interesting case is an example:—A woman was under the

¹ On the nature of these synovial follicles, see Gosselin in *Mém. de l'Acad. imp. de Méd.* vol. xvi. He there establishes the following propositions:—

I. The articular synovial membranes in general, and that of the wrist in particular, are provided with prolongations, or culs-de-sac, which he calls 'crypts' or 'synoviparous follicles.'

II. The obliteration of the orifices of these crypts, and the accumulation of synovia in their interior, is the origin of the cysts in question (i.e. the ordinary ganglions).

These two propositions are applicable to the knee-joint, though the occurrence is less common than in the wrist.

² In dissecting the popliteal space on either side in the body of a woman, æt. 38, I found on each side a large accumulation of fluid in the bursa beneath the inner head of the gastrocnemius. On one side there was no communication with the joint, which was perfectly natural, and contained no fluid. On the other side the enlarged bursa communicated with the synovial cavity, which also contained a considerable quantity of the same thick yellow fluid as the bursa. But, besides, there was on this side, adherent to the posterior surface of the ligament of Winslow, in its centre, a very small closed sac, containing similar fluid. The sac and the adjoining portion of the ligament, with its synovial lining, were removed from the body and carefully examined. No communication whatever existed, but there was a distinct pin-hole depression on the synovial face of the ligament, corresponding to the part where the cyst adhered. There were, therefore, strong grounds for regarding the latter as formed by a protrusion of the synovial membrane, or of one of the above-mentioned follicles, through the ligament.

³ *Med. Times and Gaz.* 1862, vol. i. p. 377.

care of Mr. Moore, at the Middlesex Hospital, for a smooth swelling in the popliteal space, supposed to be a bursa. In a few months after she was first seen, the tumour appeared solid, deep-seated, and was thought to be a cluster of glands. Again, ten months later, it nearly doubled the size of the knee, projecting backwards in lobes between the hamstrings and gastrocnemius. It was doubtful whether it was solid or fluid, its feeling varying at different examinations. The chief symptom was acute pain darting along the nerves to the foot. Sometimes she could not bear a touch. On puncture with a grooved needle, slightly reddened serum escaped, which, as it flowed, became more and more red, till at last it became pure blood. Whilst the needle was held steady in the tumour, she suddenly cried out from excessive pain shooting to the foot. For three or four minutes after the needle was withdrawn, the tumour remained soft; but then acquired the same tension as before. A tourniquet was applied, and the tumour cut into. The sensation to the finger was exactly that presented by the right ventricle of the heart. Nothing but blood and a few fibrinous coagula escaped; the venous bleeding was very free. The limb was amputated, and the disease then proved to be a cyst, communicating with some deep vein, and developed like a neuroma in the substance of the posterior tibial nerve, the fibrils of which were expanded in all directions over it.¹

Treatment of popliteal cysts.—The treatment of these cysts is usually successful. It may be conducted on the same principles as those already laid down in the essay on DISEASES OF THE MUSCLES as applicable to enlarged bursæ of tendons. But the frequency with which a communication exists between the enlarged bursæ of the hamstring tendons and the joint, and the probability that the cyst, if seated in the centre of the ham, may be a protrusion from the synovial membrane, should make the surgeon very cautious in treating these cysts by any of the severer methods, such as injections and setons. It is quite true that such methods have been used, and successfully, when the cyst has been known to communicate with the knee-joint; ² but they must always be held to be dangerous, and should not be resorted to unless after a patient trial of other methods (such as puncture, followed by blistering) which are free from any risk. These mild measures will often succeed when combined with rest. Nor should it be forgotten that the communication with the joint is not always obvious even in cases where it exists. The opening may be but small, and pressure on the cyst may cause no appreciable quantity of fluid to flow into the joint, unless applied for a considerable time; or the opening being of the nature of a slit,³ may be closed in the extended position of the joint, though open when the knee is flexed. In any case, if injection be the method employed, the knee should be kept firmly extended. Iodine seems the best material for injection, though alcohol and ether have been successfully employed. The injection-treatment seems to have been so successful that the difficult and dangerous method of excision ought not to be resorted to in any case; and when the cyst communicates with the joint it is wholly out of the question. Setons should be reserved for use on the failure of injection. A safe and, at the same time, efficient method of treating these cysts, is to puncture them under antiseptic precautions, and after washing them out with carbolic acid lotion (1 to 20), or chloride of zinc (40 grs. to ℥j.), to insert a drainage-tube, and apply an antiseptic dressing. The limb during the treatment should be kept on a back-splint.

The diagnosis between an *abscess* in the ham and any of the affections with which it may be confounded is usually very easy. The inflammatory appearance of the integuments would suffice to distinguish it from a cyst, as well as from a solid tumour.⁴ The chief ambiguity would be between an abscess and an aneurism in which suppuration of the sac has taken place; or between an abscess following injury and an effusion of fluid from rupture of the main vessels. On both these heads the investigation of the pulse in the artery below will give important and often decisive information. As to suppurating aneurism, the history and symptoms of aneurism will have existed, and, if the patient is a person of any intelligence, will not fail to guide the surgeon to a right conclusion. In such cases the aneurismal bruit and pulsation have generally been obliterated by the inflammation. It is true that an incision will be required, both in the abscess and in the suppurating aneurismal sac; but it is most important not to open a suppurating aneurism, believing it to be a simple abscess, since amputation may become immediately necessary: a contingency for which the surgeon should assuredly have prepared both himself and his patient.⁵

Rupture of the great vessels in the ham always, as far as recorded cases show, implicates the artery. The vein also may be torn in cases of ruptured artery; but I am unable to refer to a case where it has been the only vessel injured. The accident would be diagnosed from abscess by the suddenness of the occurrence of swelling, which comes on instantaneously at the time of the accident; the absence of inflammatory œdema or increase of temperature in the superficial parts of the ham, the loss of temperature in the foot, the failure of circulation in the lower arteries, and the tendency to gangrene.⁶

The treatment of ruptured artery has been spoken of in the essay on ANEURISM.

¹ *Med.-Chir. Trans.* vol. xlix. p. 20.

² Foucher, *op. cit.* obs. i. p. 321.

³ See a case dissected by Foucher, *op. cit.* p. 320.

⁴ It should be remembered that cysts may suppurate as well as enlarged glands, and that abscess may occur in or near a solid tumour; but then such cases become abscesses, and must be so treated.

⁵ Most readers will recollect the case, so well described by Roux (*Quarante Années*, &c. vol. ii. p. 48), in which Cullerier opened a suppurating aneurism in the groin.

⁶ Compare Poland on 'Rupture of the Popliteal Artery,' in *Guy's Hospital Reports*, ser. iii. vol. vi. 1860.

The regional surgery of the popliteal space would be very incomplete without the mention of that which is perhaps the most common cause of embarrassment in operations conducted in this region—viz. the frequent formation of a *sequestrum* in the part of the femur directly adjoining the popliteal artery. This sequestrum is seldom separated from the vessels by an invaginating sheath, as is usually the case in other parts of the body. No satisfactory cause for the commonness of the disease, or for the frequent absence of the periosteal sheath, seems to have been given. Numerous accidents in the removal of these sequestra have happened; the artery has been opened by the knife or the trephine, or lacerated by the sharp edge of the sequestrum; and cases in which the loose bone has been driven into the artery in the ordinary movements of the limb are on record, and have been referred to at vol. ii. p. 296. Hence much caution is necessary in extracting such sequestra. A free incision at one side (the outer is best) should be made, and the dissection carried along the face of the bone until the dead bone is reached. If it be not thoroughly loose, the operation had better be deferred till it shall become so. If it be found loose, it should be gently raised from its bed with an elevator, and drawn outwards with flap forceps. If the extent of the dead bone be too great to allow of its ready extraction, it is better to cut it across with the bone-scissors than to use any force. If, notwithstanding all his care, the surgeon is so unfortunate as to wound the popliteal or any large artery, he must have the circulation commanded by pressure on the femoral, while he rapidly enlarges the wound and ties both ends. Failing this, amputation has been found necessary, and even death by hæmorrhage has occurred.

Table of the Chief Surgical Affections of the Popliteal Space.

	Fluctuation	Pulsation	Bruit	External inflammation	Variation in size with the pulse	Remarks
Abscess (simple or glandular).	Yes.	Seldom, and never expanding.	No; or very rarely a simple 'thud.'	Yes.	No.	When dependent on lymphatic inflammation, there will be disease in the parts from which those vessels are derived.
Abscess from diseased bone.	Yes.	No.	No.	Usually a sinus.	No.	Thickening around the bone, which can probably be struck with the probe.
Abscess from diseased joint.	Yes.	No.	No.	Usually.	No.	Crepitus of the joint surfaces will, in all probability, be detected under chloroform.
Bursal tumour, or cyst.	Yes.	Seldom, and never expanding.	No; or merely a simple 'thud.'	No.	No.	The bursal cysts can frequently be emptied into the joint when the leg is bent; if they pulsate, this can generally be made to cease by drawing them away from the artery.
Aneurism.	Variable.	Yes, almost always.	Usually.	No.	Yes.	
Aneurism, suppurating.	Yes.	Probably.	Usually.	Yes.	Usually not.	The pulse below is probably affected.
Rupture of artery.	Yes.	Not usually.	Variable.	No.	Cannot often be made out.	The history is generally decisive; the swelling and colour of the limb, the loss of temperature and the impending gangrene, are also generally unmistakable symptoms.
Glandular tumour.	No.	Seldom, and never expanding.	No; or merely a simple 'thud.'	Usually not.	No.	The same remarks apply as to glandular abscess.
Other innocent tumour.	As above.	As above.	As above.	No.	No.	This and the preceding tumour can usually be drawn away from the course of the vessels, like the bursal cysts.
Cancer.	Variable and varying in different parts of the tumour.	No.	As above.	No.	No.	The rapid increase in the tumour and the large veins over it are frequent symptoms.
" pulsatile.	Sometimes.	Yes.	Not usually.	Seldom.	Yes.	As above; it is only in rare cases that the bruit simulates that of aneurism. The bone is commonly enlarged for some distance.

The Limbs

In the continuity of the limbs, the chief questions connected with regional surgery which occur in practice are those which relate to the relative positions of arteries and nerves to tumours or diseased portions of bone. Interesting points of surgical anatomy are frequently raised by these operations, but they are too numerous and too miscellaneous for discussion here. An intimate and ready knowledge of anatomy is the chief requisite for safely conducting such operations; but the surgeon must not forget that tumours and abscesses often displace the structures. An instance of this has been given at vol. ii. p. 296, in the displacement which the femoral artery suffers in chronic abscess of the thigh; and similar displacements are of course still more common when tumours grow among the main vessels and nerves of a limb. For this reason, in the removal of such tumours, it is very desirable to commence the dissection from above, where the structures have their natural position, and thence trace them downwards. But the affections of the limbs have been so extensively described in the essays on the DISEASES OF THE MUSCULAR SYSTEM, BONES, JOINTS, and SKIN, that I must refer the reader to those essays for all that is necessary on their diagnosis and treatment.

T. HOLMES, 1871.

R. J. GODLEE, 1882.



I N D E X.

[Titles of Essays are printed in small capitals; references unaccompanied by number of volume are to the volume last stated.]

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